ECHNOLOGY DEPARTMENT

Power Generation

INCLUDING Power Plant ENGINEERING ESTABLISHED 1896

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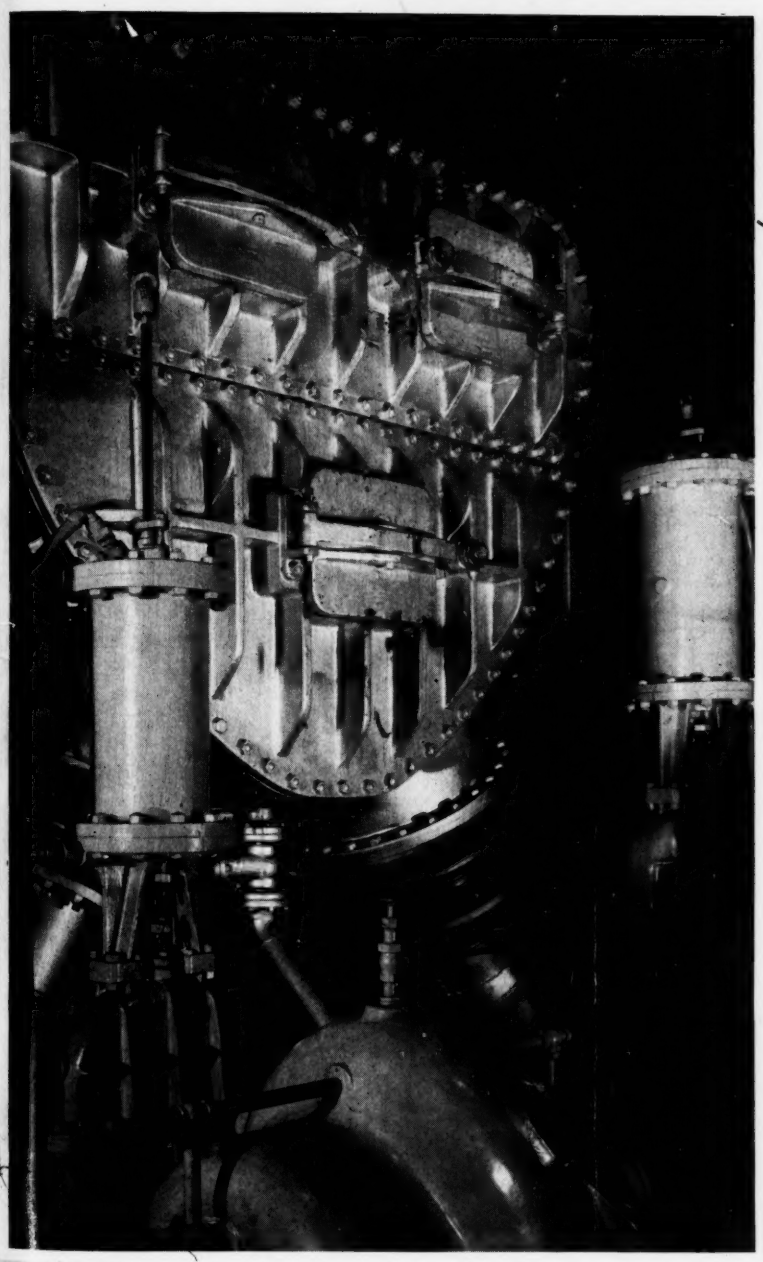

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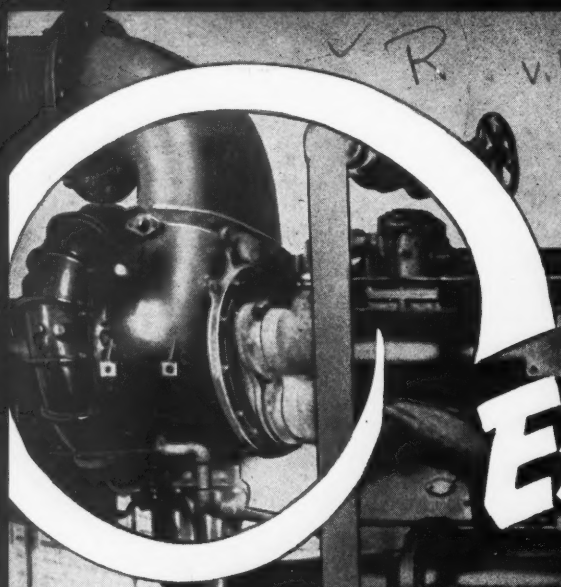
VIEW OF SURFACE CONDENSER INSTALLED WITH A 20,000-KW TURBINE GENERATOR IN A CALIFORNIA POWER PLANT. CONDENSER HANDLES 146,550 LB STEAM AN HOUR. CIRCULATING PUMP AND POWER-OPERATED CIRCULATING WATER CONTROL VALVES IN FOREGROUND. (Ingersoll-Rand photo)

The Magazine That Helps Men Responsible for Generation of Steam, Electricity and All Other Forms of Power Supply

R. v.52² July-Dec. 1948



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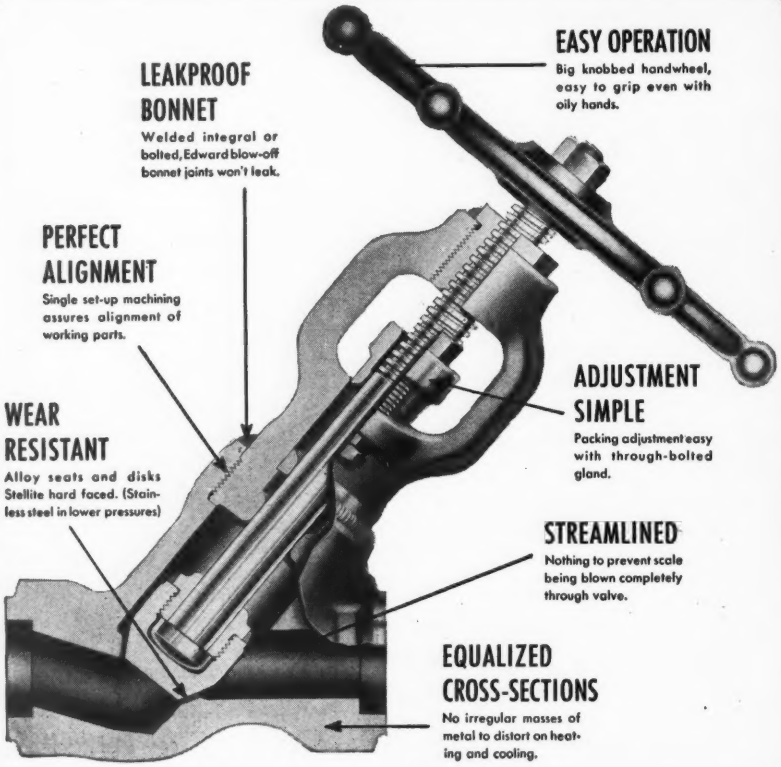
TEMPERATURE VARIATIONS, ABRASIVE SCALE NO PROBLEM WITH Edward BLOW-OFF VALVES


EASY OPERATION
Big knobbed handwheel, easy to grip even with oily hands.
LEAKPROOF BONNET
Welded integral or bolted, Edward blow-off bonnet joints won't leak.
PERFECT ALIGNMENT
Single set-up machining assures alignment of working parts.
ADJUSTMENT SIMPLE
Packing adjustment easy with through-bolted gland.
WEAR RESISTANT
Alloy seats and disks Stellite hard faced. (Stainless steel in lower pressures)
STREAMLINED
Nothing to prevent scale being blown completely through valve.
EQUALIZED CROSS-SECTIONS
No irregular masses of metal to distort on heating and cooling.

The vicious punishment of blow-off valve service—abrasive action of grit and scale—severe strains caused by violent temperature swings—finds its match in Edward blow-off valves.

Special hard surfacing equipment, developed at Edward, prepares seats and disks for a long life of resistance to the grinding wear of sediment blown through the valve at high velocities.

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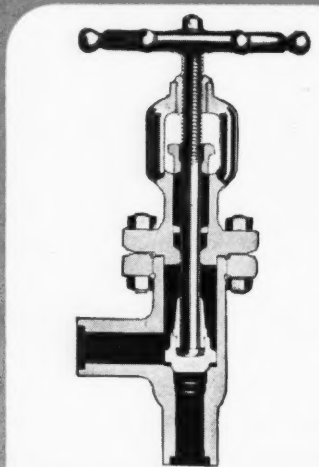
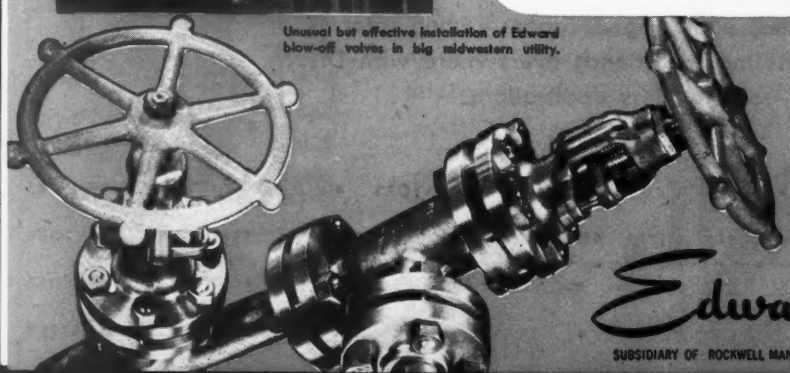
LOW MAINTENANCE
PIPING FLEXIBILITY
SLOW OPENING
EASY REPACKING
TIGHT CLOSURE
LONG LIFE

Unusual but effective installation of Edward blow-off valves in big midwestern utility.



Typical Edward angle bolted bonnet blow-off valve. Choice of straightway or angle designs gives maximum piping flexibility.



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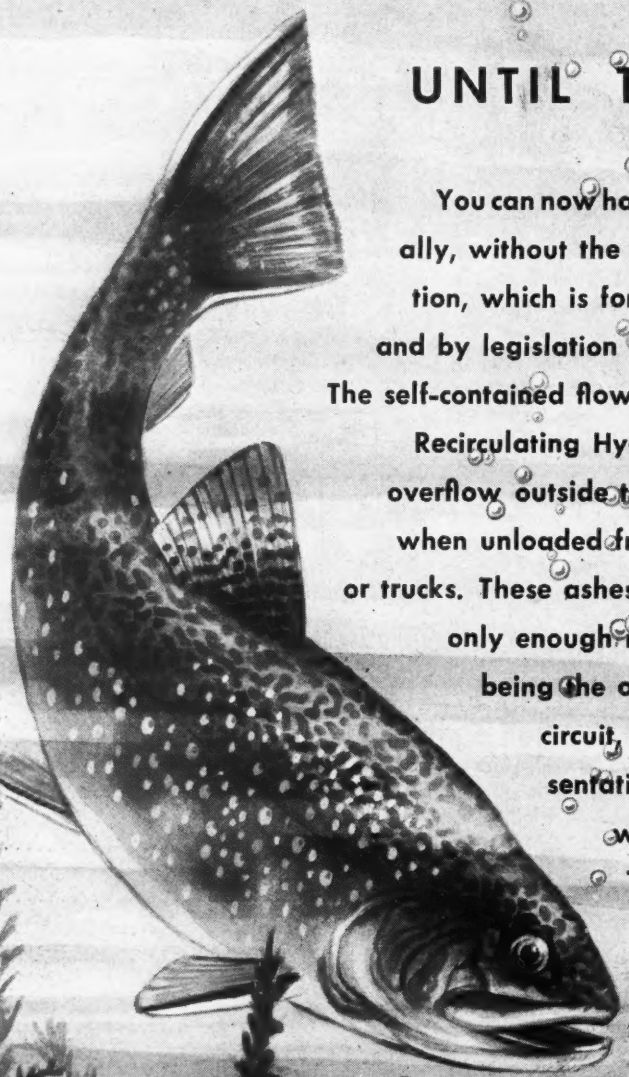
Let the Fish Live

UNTIL THEY'RE CAUGHT



You can now handle any daily ash tonnage, hydraulically, without the slightest hazard of stream pollution, which is forbidden by the laws of many states and by legislation under consideration in others. The self-contained flow of water and ashes in the Recirculating Hydrojet System has no discharge or overflow outside the system, aside from the ashes, when unloaded from the Hydro Bin into railroad cars or trucks. These ashes are commercially dry and contain only enough moisture to prevent dust escape. This, being the only moisture to leave the enclosed circuit, becomes the only make-up. Our representatives have new Engineering Drawings which illustrate this Hydrojet Hook-up. They will gladly call on you anytime to explain how the system can be applied to new or existing installations.

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ENGINEERS' PREVIEW

GERIATRICS, the portion of medical science concerned with old age and its diseases, is not by any means a new field, but it is beginning to assume a much more important place in our thinking than it ever did before. Not only to the individual who is growing older but to industry as well, some of the problems of old age will have to be taken up in a positive manner for a number of reasons. From the point of view of industrial relations, it is becoming increasingly important because, with the increasing life span of a larger and larger proportion of our population, more people do not want to retire from their jobs as they get older. Some of these problems are discussed in a very interesting and practical way by J. P. Flemming in the *Edison Electric Institute Bulletin*, March 1948.

In Massachusetts, about 1800, the average age at death was 35 years. In 1948, the life expectancy in the United States is 65 years. These extra years are creating social and personal problems. In previous generations the old had a place in the households of their children, most of whom lived on farms. There the old people were useful—Grandfather as a chore boy and general handy man, Grandmother as baby sitter and knitter of socks. But today the farm is not a refuge for the aged. Less than one-fifth of American families live on farms and the city family seldom has a place for the elders.

Mr. Flemming discusses some of the things industrial management may do to consult with its older employes about what they are going to do upon retirement. The question of how and where they are going to live is important. Another point is whether or not the industrial pension system should be revamped to recognize that retirement should be based on ability, not age.

Today some of the larger and more farsighted industries are making an effort to provide opportunities for older and handicapped workers to continue work. The Dodge Division of Chrysler Corp. and the Hudson Motor Car Co. have special workshops where veteran employes who cannot maintain the necessary pace in other departments are eligible to work at their own speed, the job being adjusted to the man, not the man to the job. It is sensible to desire to utilize the good judgment and experience of older workers.

One of the important things discovered by geriatricians is that persons who plan upon retiring to give up all activities, and thereby achieve what they suppose is unconfined bliss, may have to reckon with senile dementia. Every person should be encouraged to have a hobby of some kind and take a keen interest in it if he retires from work.

It is interesting to note that several communities throughout the country have been specifically designed and built to attract elderly people. This problem of the aged deserves much thought and concerns every one of us, not only as engineers or business men but also as citizens.

★ ★ ★

FORMATION and objectives of the new BCR Mining Development Committee, which expects to design a continuous mining machine in the next two years, was announced at the recent BCR Annual Convention in Columbus, Ohio, by Dr. Charles E. Lawall, assistant vice president of coal traffic and development of the C & O Railway Co.

FOR THOSE photographic hobbyists who like to experiment with the unusual, there is a newly patented glass in which photographs can be printed. Yes, says the *Ohmite News* in reporting this, "in" is the right word, because the glass actually receives permanent colored prints with a three-dimensional effect. The photograph is printed in the glass by means of ultraviolet light and heat.

★ ★ ★

THE NEW NATIONAL government of India is working on a dozen or more hydroelectric schemes designed to provide approximately 4,000,000 kw of electric energy to numerous industrial plants in India that are being set up or will be set up in the future, to operate pumping machinery for irrigation and drainage, and for domestic use. Some of the projects are, like the TVA, multi-purpose. In addition to power generation, high-level irrigation and navigation are other objectives. The most spectacular project is the dam across the Kosi river near Barahkshetra in Nepal territory. The dam will be 750 ft to 850 ft above bedrock and will be the highest dam in the world. The power station at the dam will have an installed capacity of 1,800,000 kw. Construction is expected to take years and cost about $300,000,000. American engineers, including Dr. J. L. Savage, are consulting with Indian engineers on these projects. Another important dam, across the Godavari river, will be 420 ft high and 600 ft long, and will generate approximately 100,000 kw. Still another, called the Damodar Valley project will generate 300,000 kw, and will not only provide irrigation for 800,000 acres but will permit navigation up to a large coal field area.

★ ★ ★

WALTER WILLIAMS, newly elected chairman of the Committee for Economic Development, has outlined the program of research on national economic problems that the CED will continue as a permanent organization. Mr. Williams succeeds Paul G. Hoffman, who has been chairman of CED since it was founded, and who has recently been named head of the European Recovery Program. According to Mr. Williams, the CED will go ahead with its research studies in such subjects as economic stabilization, adequate supply of investment capital, management of the public debt, labor management relations and others, and its program will be broadened and deepened to meet changing world conditions.

★ ★ ★

MANUFACTURE of oxygen by large consumers for their own use has had its ups and downs. For many years the tendency has been to buy the gas from specialized producers. But recently, as *Business Week* points out, the trend has turned. Ford Motor Co. emphasized the shift this week by getting into the oxygen making business for itself. Ford will have four oxygen units at its River Rouge plant, capable of producing 23 tons of oxygen a day and, as a by-product, 75 tons of nitrogen per day. The system will also include storage facilities for about 200 tons of oxygen, held under 2200 psi, for release at peak-load periods. Most of the oxygen will go to the Ford steel mills for scarfing hot blooms, billets and slabs, and oxygen will also be used in welding.

REPRESENTATIVES of eight manufacturers of spreader stokers and of Bituminous Coal Research, Inc., met recently to study means for improving utilization of bituminous coal. This meeting was brought about by the increasing acceptance of spreader stoker firing in industrial and public utility plants and a desire to extend its versatility and overall efficiency.

A Spreader Stoker Research Committee was formed to administer the program. William S. Major, development engineer of Bituminous Coal Research, Inc., was elected chairman of the committee, which includes two representatives from the bituminous coal industry, one from each of the co-operating spreader stoker manufacturers and two from Bituminous Coal Research, Inc. Plans were formulated to conduct research tests on a representative size and type of spreader stoker-fired boiler, under the supervision of fuel engineering staff of Battelle Memorial Institute, Columbus, Ohio.

★ ★ ★

ELECTRIC POWER supply situation in the United States will be approximately the same for 1948 as it was for 1947—tight but adequate—said Charles E. Oakes, president of the Edison Electric Institute recently, in announcing the findings of the third nationwide power survey. The results of this survey have been made available to the National Security Resources Board at Washington. In brief, they show that (1) the U. S. has an adequate power supply at present, although reserve margins are narrow; (2) there is a remarkably high degree of system co-ordination to get the most out of all the generating facilities within different areas; (3) everything is being done that can practically be done to add new capacity; (4) the turbine factories are loaded to capacity; (5) in three years the country will be back to normal reserves. Steam turbine manufacturers are booked to capacity three years ahead. Generators are being produced at the rate of 5,500,000 kw per year for central stations, and another 500,000 kw for industrial plants.

At the same time, the demand for electric power continues to rise month by month. New and expanded uses of electricity are developing and labor costs are placing a high premium on greater applications of electric power. Last year's volume of manufacture of electrical appliances was 5 times the pre-war volume. The electric industry expects to install about 4,600,000 kw of new generating capacity this year.

In case of war, the nation would again be confronted with a conversion from civilian to wartime production —around-the-clock operation of factories, shortages of manpower, shortages of material and shortages of transportation. According to Mr. Oakes, electric power generally is not regarded as the critical or limiting factor in such a situation.

★ ★ ★

AT THE RECENT Anthracite Conference at Lehigh University, J. F. Barkley, Chief, Fuels Utilization Branch, U. S. Bureau of Mines, urged that the anthracite industry, though it produces a smokeless fuel, do all it can in the interests of smoke abatement. He suggested that "anthracite often can be offered as an admixture where bituminous coal is being used in equipment improperly designed for smokeless operation or in equipment poorly operated from a smoke-production standpoint." Wartime tests, undertaken by the Bureau of Mines as a fuel conservation measure, showed, according to Mr. Barkley, "that less smoke was always produced when anthracite was added to bituminous."

RAPID ADVANCE in the design of tanks for rocket power plants, was forecast by speakers at the recent semi-annual ASME Meeting in Milwaukee. Complex problems have resulted from the requirement for light weight, coupled with high tensile strength and the ability to withstand extreme high pressures. These problems are gradually being solved, as a result of new data on design factors, welding procedures and the mechanical properties of high strength metals.

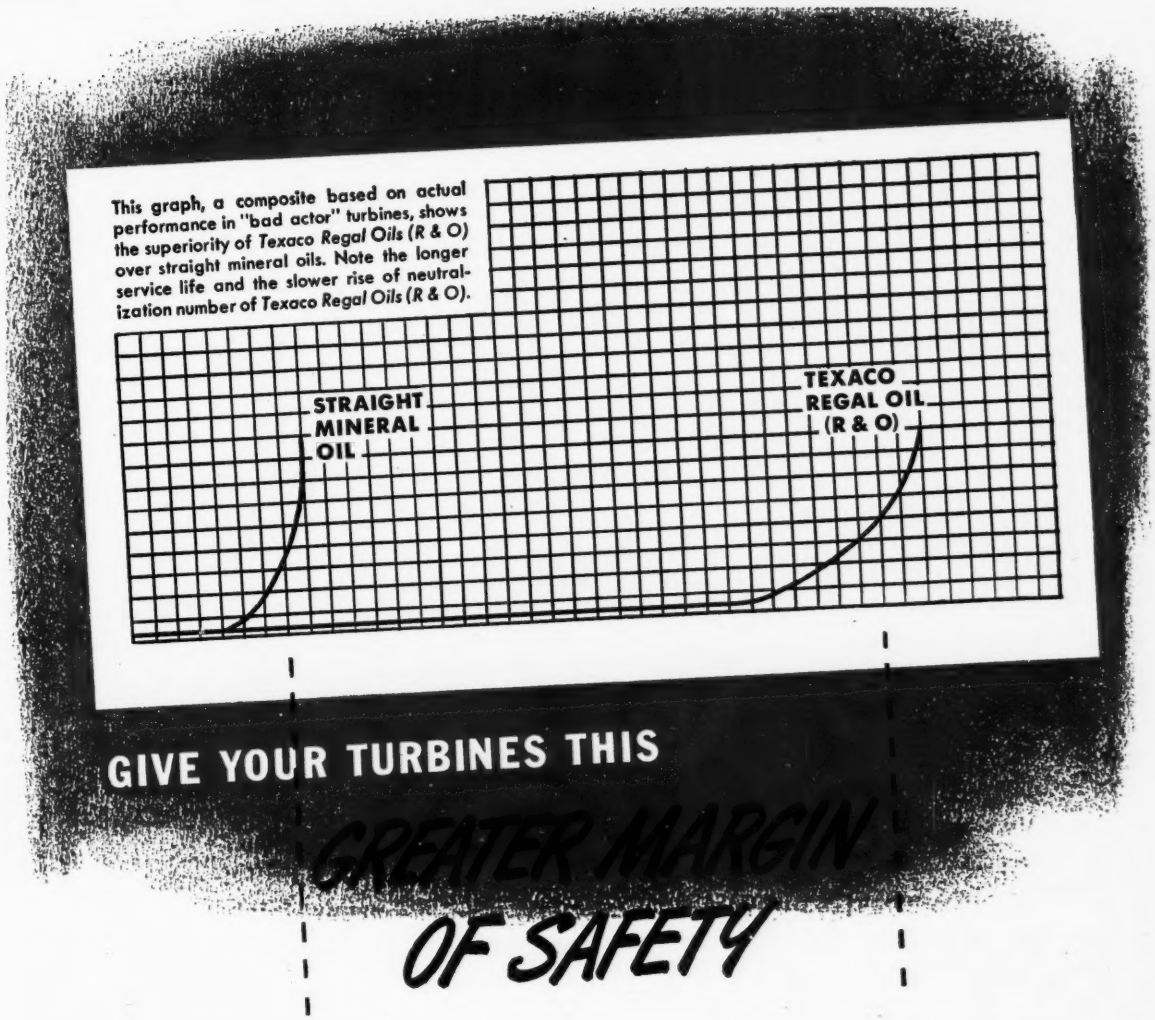
The various factors were discussed by C. C. Ross and R. B. Young of Aerojet Engineering Corp., and by John J. Chyle and Harold W. Brock of A. O. Smith Corp. The bulk of propellants carried in a rocket powered missile or aircraft represents the major portion of the initial gross weight, varying according to the design from 60 per cent to 75 per cent. Hence the design and construction of the tanks greatly affect the performance of the vehicle. This design is very stringently governed by weight, alignment and shape factors and the large size of the tanks makes adequate and uniform heat treated properties very hard to obtain. Finally, since most rocket power plants are expendable and are needed in large numbers, non-critical materials must be used wherever possible. Fabrication of high-tension alloys was discussed by Mr. Chyle, who said that the development of new welding procedures now makes possible tensile strengths in alloy steel up to 200,000 psi.

★ ★ ★

SIMPLIFIED PRACTICE recommendation for copper and copper-alloy round seamless tube, identified as R235-48, has been issued by the National Bureau of Standards. The recommendation was proposed by the Copper & Brass Research Association on behalf of manufacturers of copper tubes. Adoption of the preferred sizes listed should enable the tube mills to schedule longer runs with less frequent resetting of tools, and the repetition of orders for similar sizes should in time permit the building of stocks and thus facilitate production and distribution. Mimeographed copies of the recommendation may be obtained without charge from the Commodity Standards Division, National Bureau of Standards, Washington 25, D. C.

★ ★ ★

INTENSIVE PROGRAM for eliminating smoke in Columbus, Ohio is now being undertaken under the auspices of the Coal Producers Committee for Smoke Abatement. At the suggestion of the Columbus Division of Smoke Regulation and Inspection, ten engineers have been studying 100 public and parochial schools to determine the performance of their equipment. The committee has completed recommendations for these plants, many of which have been on the smoking list for years. The next phase of the program will include all public buildings and institutions. The plan is to have the schools and city set the example, on the ground that it is unfair to make private industry clean up its stacks before municipal smoke is abated. H. B. Lammers, Chairman of the Coal Producers Committee, states there is much interest throughout the city in smoke abatement. Columbus was selected as a laboratory, to prove that it is not necessary to have smoke palls over our industrial centers, because it had an adequate smoke ordinance, popular support for smoke abatement, was a convention center where thousands of visitors could see the results and carry the story away, was a railroad center and had large and diversified industrial activity. This major effort cannot be accomplished over night. There is only one way to do the job—smoke must be abated plant by plant.


This graph, a composite based on actual performance in "bad actor" turbines, shows the superiority of Texaco Regal Oils (R & O) over straight mineral oils. Note the longer service life and the slower rise of neutralization number of Texaco Regal Oils (R & O).
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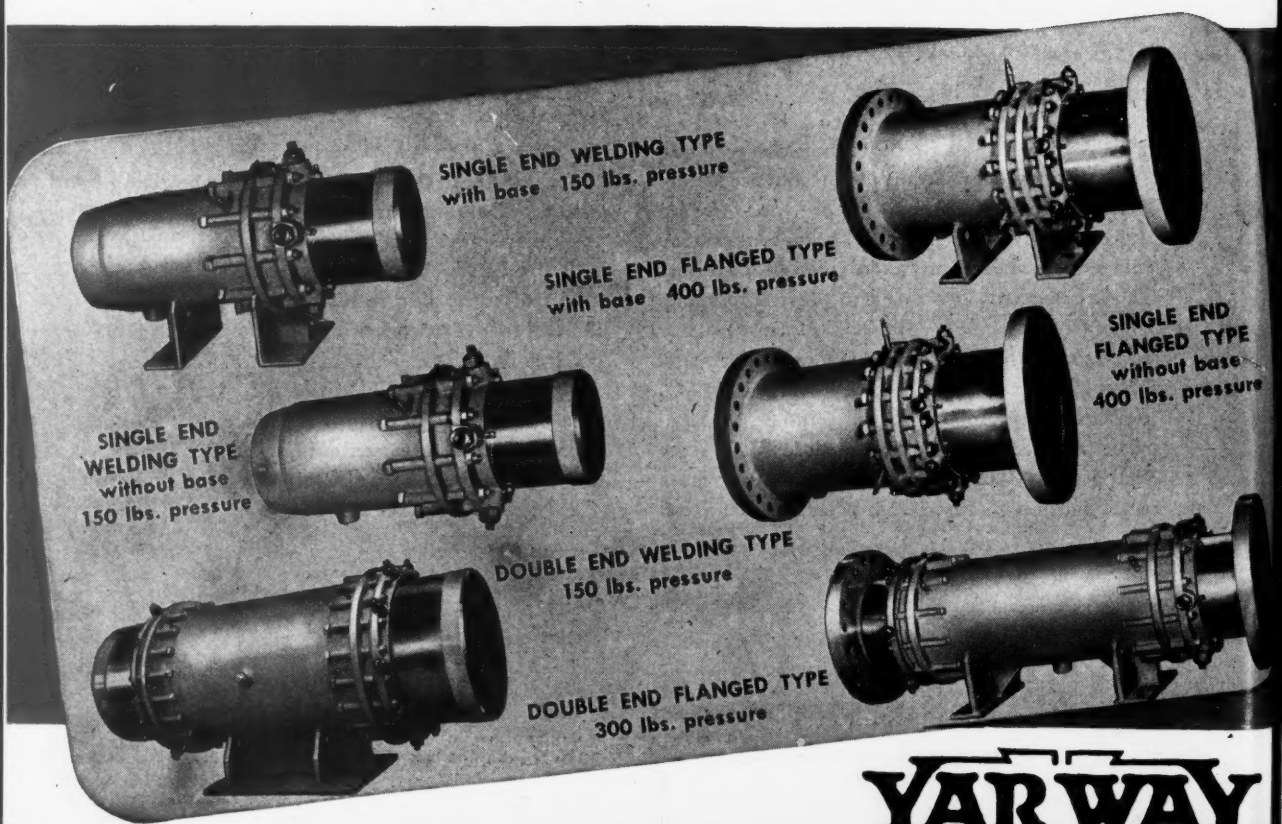
Tune in...Texaco Star Theatre every Wednesday night featuring Gordon MacRae and Evelyn Knight...ABC Network

Stop ...shutdown losses and production delays

Look...at the record low maintenance costs

Listen ...to what users say about...

"GUN-PAKT"



YARWAY

JOINTS

YARWAY "GUN-PAKT" EXPANSION JOINTS

Yarway "Gun-Pakt" Expansion Joints are more than an improved expansion joint... they are a revolutionary idea that has won the enthusiastic approval of steamplant engineers from coast to coast.

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"Gun-Pakt" also means minimum maintenance. One user of 66 "Gun-Pakt" joints kept a record for 14 years—the average cost of materials to service joints was only 65 cents per year per joint! Another user, a large utility, maintains over 100 Yarway "Gun-Pakt" joints at a cost of only $1.50 per month for packing for all joints.

No wonder plants like one of Detroit's largest motor car manufacturers are saying, "We want 'Gun-Pakt' joints and nothing else!"

For the full story on Yarway "Gun-Pakt" Expansion Joints, write for Bulletin EJ-1911.

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GUN-PAKT EXPANSION JOINTS

GP

Great Performance

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THE GARLOCK PACKING CO., PALMYRA, N.Y.
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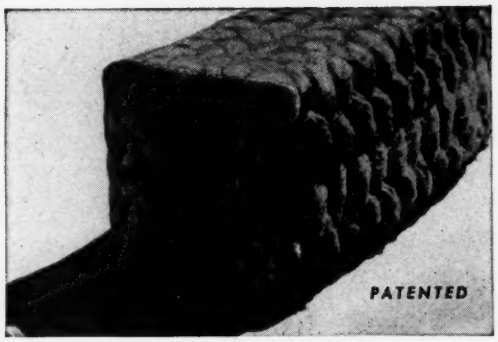
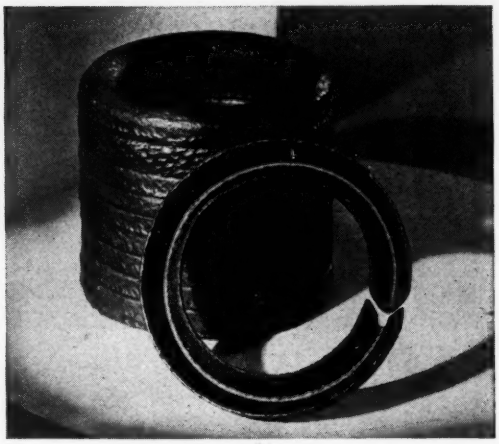
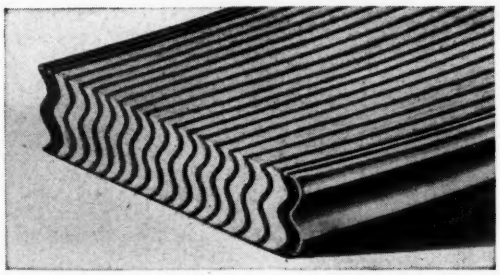


GARLOCK Lattice-Braid Packing



GARLOCK Chevron* Packing



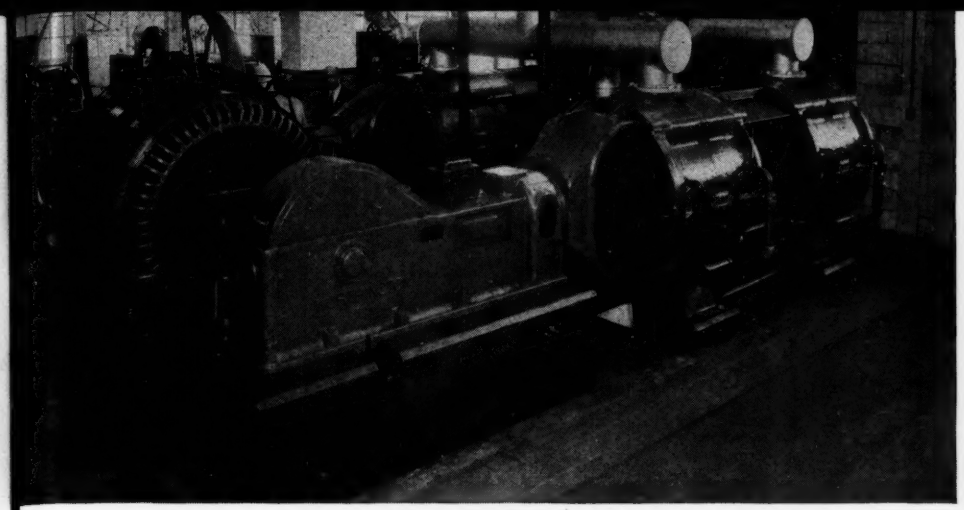
GARLOCK Guardian* Gasket (Cross section view)

*REG. U.S. PAT. OFF.

NEWS

FROM THE POWER FRONT

AS REPORTED BY THE DEVELOPMENT ENGINEERS FIELD SERVICE REPRESENTATIVES AND CUSTOMERS OF WORTHINGTON



Worthington 32 x 16 Twin Tandem Vacuum Pump at Buffalo Electrochemical Co. Inc.

Triples the Run

Hydrogen Peroxide is manufactured by Buffalo Electrochemical Co. Inc.

Originally, vacuum pumps of the slide-valve type were used, and these were imported from Switzerland because no other pumps were available in this country that could meet specifications at a reasonable price. During the war—at the very time production requirements expanded—the Swiss pumps were unavailable. So BECCO engineers made a thorough study of all domestic pumps to determine which make would handle the highly oxidizing and corrosive gases with the least possibility of failure.

The result of the investigation was the selection of a Worthington 32 x 16 twin-tandem, two-stage, four-cylinder dry vacuum pump. The reason for the selection was chiefly the simplicity of the Worthington Feather* Valve, the lightest, tightest, quietest ever made.

Although the installation was considered experimental, inspection following the initial 10-week run showed that its performance exceeded that of the original Swiss pumps. Since then, the Worthington pump has operated on regular 10-week periods between inspections and cleaning, as compared with previous 3-week periods.

The pump is rated at 5571 cfm displacement—approximately 20% larger than other existing pumps—and is suitable for handling vacuum down to 0.25 in. Hg absolute. The guaranteed vacuum on blank suction of 0.25 in. has been exceeded.

Reg. U.S. Pat. Off.

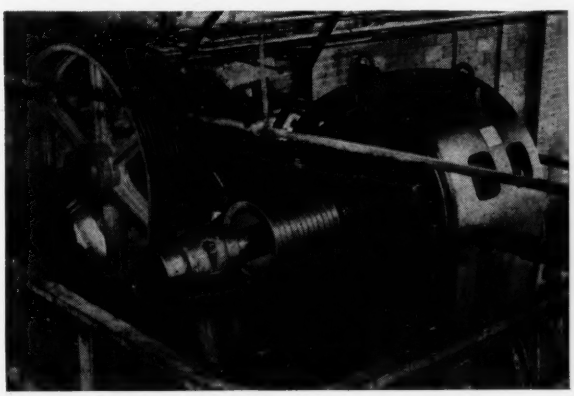
All Quiet on the Clay Machine

A chain drive to a 150 hp clay machine in an Akron, Ohio, plant had been annoying workers with its noise and keeping maintenance men busy with repairs. Each case of break-down involved work interruption for at least a dozen men.

To replace the chain drive, a Worthington Multi-V-Drive was installed—14.5 in. QD driver sheave and 58.0 in. QD driven sheave, with 12 Worthington-Goodyear Steel Cable V-Belts, "D" Section.

This unit is driving a line shaft transmitting 150 hp from flat belting to two pug mills which operate one at a time. The drive is designed to meet this change-over in operation. The drive motor is rated at 300 hp.

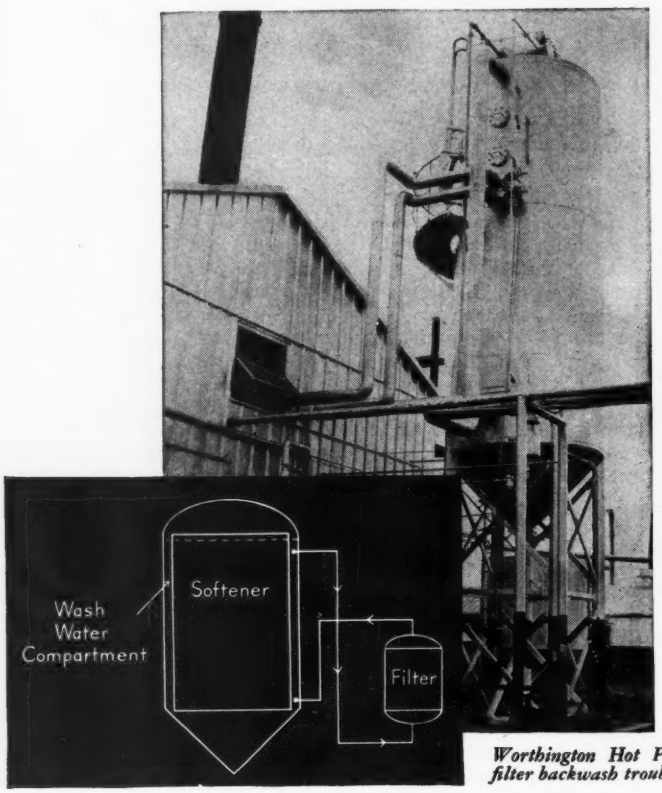
The job was installed and operating seven and one-half hours after arrival at the plant.



Worthington—Goodyear Multi-V-Drive on clay machine (pug Mill) in Akron plant.

NEWS from the power front

The Only Uniformly Continuous Hot Process Water Softener



Worthington Hot Process Deaerating Softener design eliminates filter backwash troubles.

Continuously uniform water treating results can be obtained only if treating process remains undisturbed during recirculation of filter backwash water.

Worthington's exclusive design completely divorces the filter backwashing operation from the treating process, thereby permitting continuously uniform treatment and preventing filter deterioration.

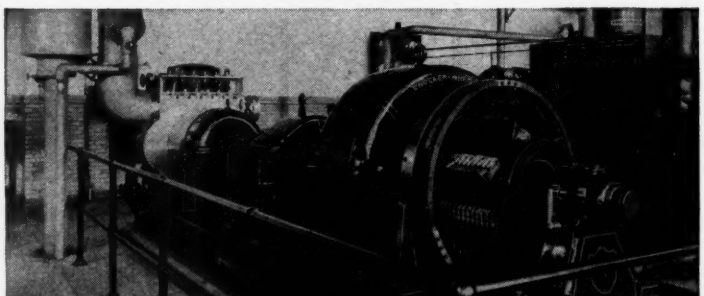
A wash water storage and settling compartment (see diagram) provides clear, hot, deposit-free water for backwashing purposes, thereby eliminating filter difficulties, increasing the period between backwashing operations and decreasing the time of the backwashing operation. The filter is washed clean with clean water without disturbing the softening process.

10 Years in a Hospital and Never a Patient

Ten years ago, the Oak Forest Infirmary in Oak Forest, Illinois, installed a Worthington 600 kw geared direct-current turbine-generating unit.

Over the ten years, the unit has operated continuously and without attention in the way of service except for an inspection every four or five years.

The machine is a non-condensing unit operating on steam at 150 lb initial pressure, 0 deg F superheat, and exhausting to 3 lb back pressure. The exhaust is used for heating water, cooling, baking and to heat various buildings in the institution. No live steam direct from the boilers is used for heating since, in addition to the turbine-generating unit, most of the auxiliaries such as pumps and fans are steam-driven.



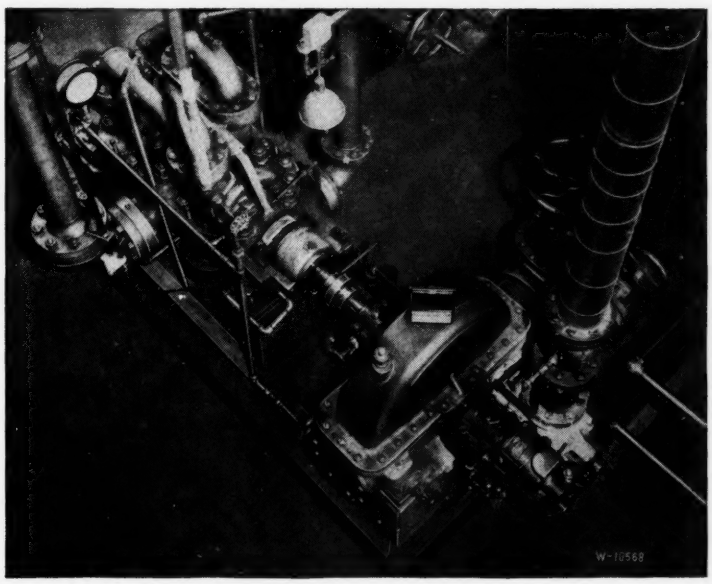
Worthington Turbine-Generator—Oak Forest Infirmary, Oak Forest, Ill.

It is estimated that the savings made by running their own plant, over the cost of purchased power and generating steam for heating only, have been substantial, paying for the Worthington unit a number of times over.

Worthington Pump and Machinery Corporation
Harrison, N. J.

NEWS

Pumping for Pipe Testing



Worthington 4-UX-1 Pump and Worthington T2RA Turbine . . . supplying high pressure water, A. M. Byers Company, Pittsburgh, Penna.

A. M. Byers Company, as you probably know, manufactures wrought iron pipe for many purposes—particularly for the fast-becoming-popular radiant type of heating.

All its pipe is carefully tested in the plant, and for this purpose it uses a weighted accumulator system. To supply the high pressure water, Byers selected a Worthington pump and Worthington turbine. Choice of the Worthington equipment was based primarily on its compactness, economy in steam consumption, and the speed with which it gets into operation.

The pump is a 4-UX-1, designed for capacities between 350 gpm and 500 gpm, producing 800 lb TDH with 50 ft or more of suction pressure. It runs at 3600 rpm, and the minimum BHP required at the maximum condition is 334.

The turbine is rated 350 hp at 3600 rpm, and operates on 156 lb steam with 50F superheat and 2 lb gauge back pressure. It is equipped with a hand speed changer.

Sewage Gas Engine Returns $199,000

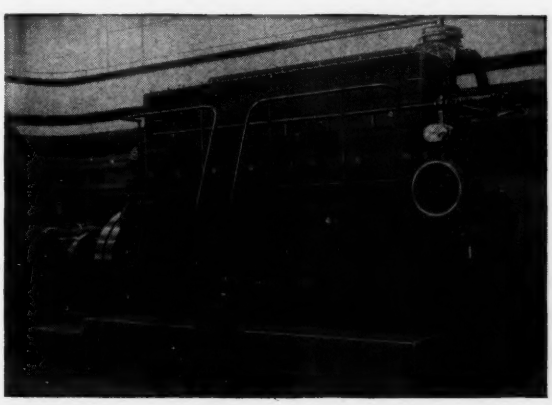
The annual report of the Fort Wayne (Indiana) sewage treatment plant reveals a 1946 saving of $38,000 by the 465 hp Worthington gas engine installation. This brings the total six-year saving to $199,000.

This plant, considered one of the outstanding municipal developments in the country and a focal point for inspection tours by engineers from other communities, was completed in 1940. Fort Wayne had been mandated by the Indiana State Board of Health to cease pollution of the Maumee River, and now the treated sewage is so free of offensive material that the river is capable of sustaining fish life.

Total sewage treated in 1946 amounted to 6,648,960,000 gallons—an average of 18.73 million a day. From this 7,000 tons of sludge was removed, and into it 5,345,890,000 cubic feet of air was pumped.

The Worthington gas engine was originally purchased at a cost of $30,000. The estimated saving is based on what it would have cost otherwise for additional electric power.

The engine contributes to heating the sludge digesters. The sludge is pumped in liquid form into four covered digesters where it is decomposed by bacteriological action, producing methane gas. Heat from the circulating water in the engine is used to raise the temperature of the sludge to the desired point for proper bacteriological digestion. In 1946, nine billion BTU's of heat went from the engine to the digesters—equivalent to 650 tons of coal.



Worthington Sewage Gas Engine—Fort Wayne, Indiana, Sewage Treatment Plant.

Fully

...THE HAGAN DIFFERENTIAL MASTER

You get the full benefit of automatic combustion control only when you have a combustion control system which is *fully* automatic.

You are not getting full benefit if manual adjustment is needed when there is a change in fuels, when a pulverizer is shut down, when coal gets wet, or when feeder characteristics change. You lose not only the time required to make the adjustment, but also the time spent in watching for the need of it.

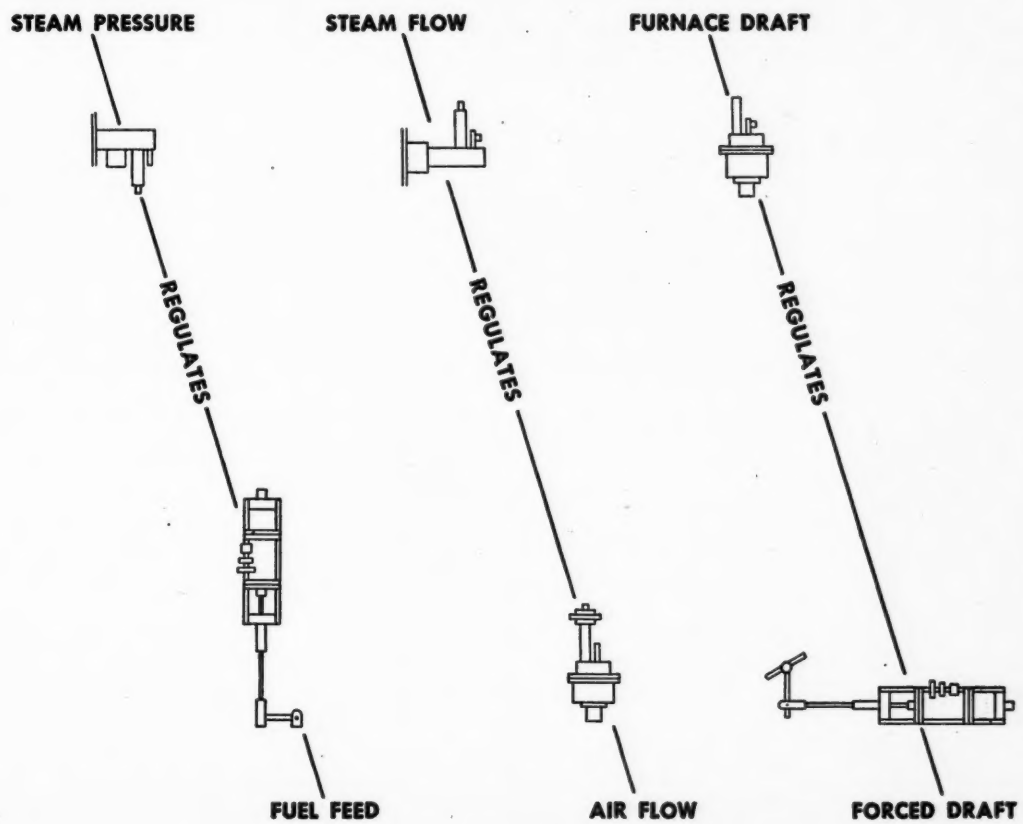
The Hagan Differential Master method of combustion control *is* fully automatic. The method employed is simple. A Hagan Master Sender, which is sensitive to steam header pressure, controls heat input in accordance with demand. A Hagan Differential Master Sender, measuring steam flow, regulates air flow. The boiler unit itself thus becomes a calorimeter of heat input.

The Hagan Differential Master system is in service with boilers burning gas, oil, pulverized coal and various combinations of these fuels. Boiler sizes in these installations range from 30,000 lb./hr. at 200 p.s.i. to 650,000 lb./hr. at 1,800 p.s.i. In every situation it has proved to be accurate, reliable, and easy to operate.

Hagan engineers will be glad to show you the advantages offered by the Differential Master method in your plant. Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

automatic

METHOD OF COMBUSTION CONTROL



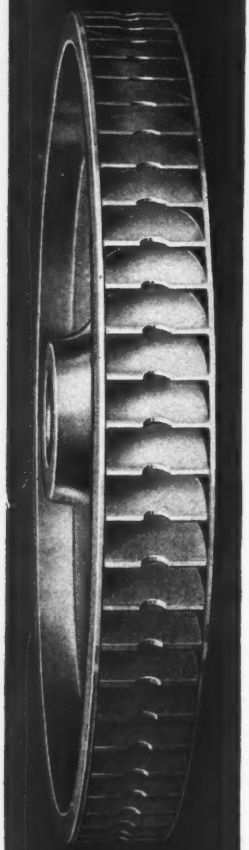
HAGAN CORPORATION

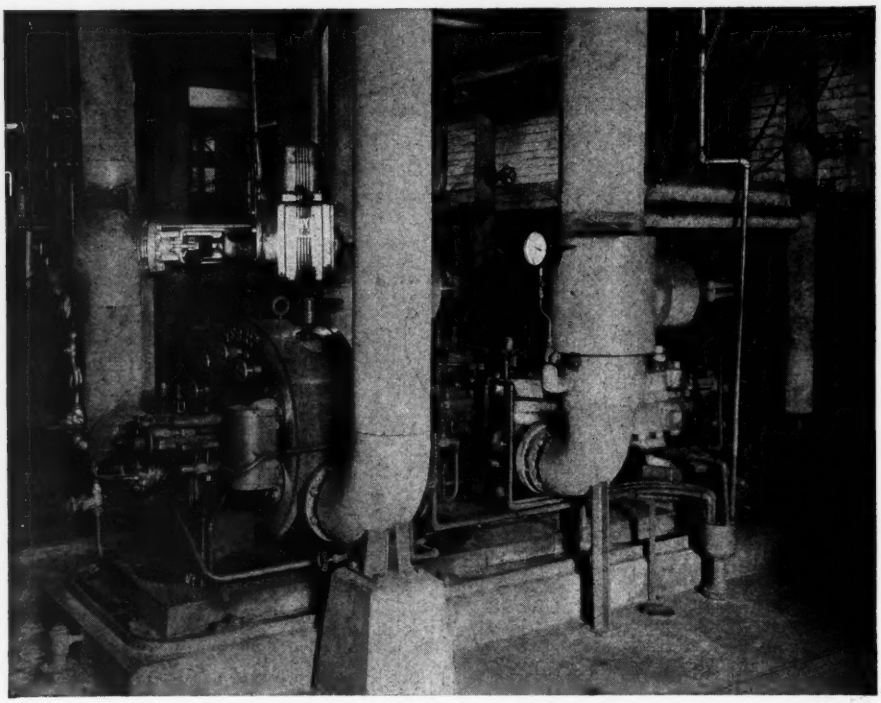
HAGAN
HALL
BUROMIN
CALGON

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

DETROIT PUBLIC LIBRARY

TERRY





This 600 hp high pressure, high temperature Terry Turbine is used to drive a boiler feed pump.

WHY
AMPLE BLADE CLEARANCES ARE SO IMPORTANT

This Terry Turbine has large radial and axial clearances.

If radial clearance should become reduced, the blades are protected by projecting rims at sides.

The side clearance — one inch — is so large that possible end play from excessive external thrust can cause no damage to the wheel. And frequent inspection of thrust bearings is unnecessary.

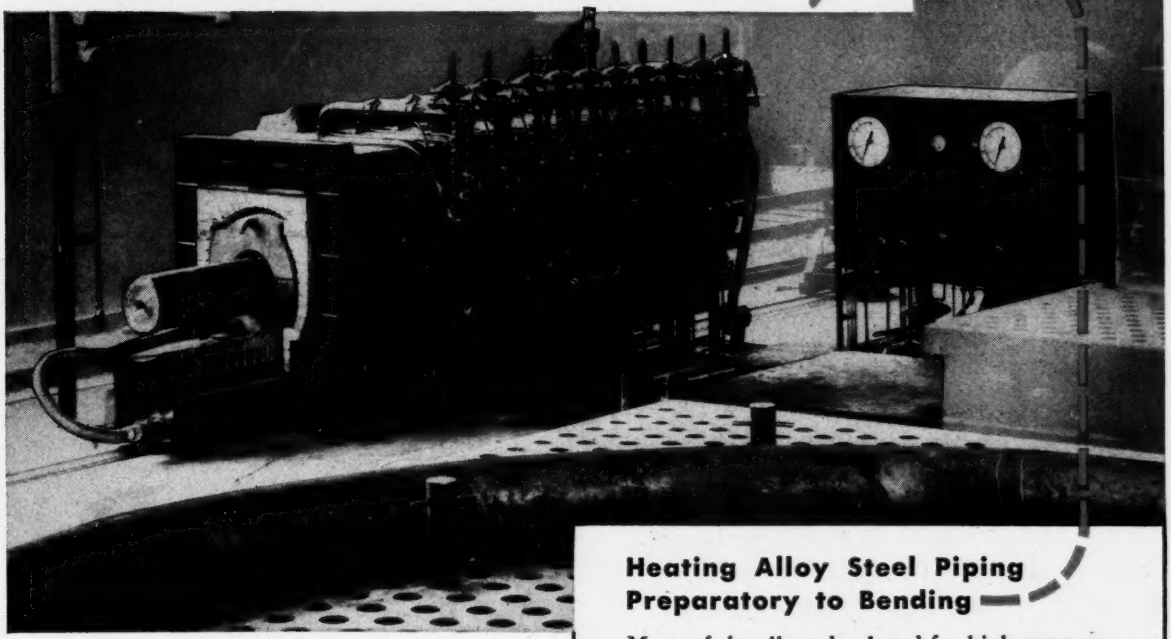
Write us on your business letterhead for a copy of Terry Bulletin S-116 describing these construction features and other Terry advantages.

Our district representative will be glad to discuss your specific turbine drive problem with you.

T-1173

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

IF THERE EVER WAS A JOB FOR SPECIALISTS– *THIS IS IT!*



Prefabricated Piping from GRINNELL assures you *QUALITY*

Grinnell interpretive engineering, metallurgical research, specialized facilities, skilled personnel and rigid inspection, assure delivery of pretested and certified piping sub-assemblies which meet all governing code requirements.

Prefabricated Piping from GRINNELL assures you *ECONOMY*

One source for design and fabrication. Coordination of shop production under ideal conditions. Predetermined but flexible delivery schedules. Elimination of waste by paying only for finished assemblies. Reduction in field assembly time.

Heating Alloy Steel Piping Preparatory to Bending

Many of the alloys developed for high-pressure, high-temperature services and for corrosion-resistant applications are susceptible to loss of their valuable properties within certain temperature ranges as a result of excessive changes in metallurgical structure, surface oxidation, heat shock and cracking.

Only furnaces equipped to maintain accurately the specified temperature of the pipe are capable of retaining and safeguarding the metallurgical properties which dictate the choice of material.

Grinnell's modern pipe fabrication equipment includes specially designed gas-fired *radiant heat* furnaces, with such features as strategic location of multiple burners providing uniform temperature distribution and preventing harmful flame impingement, close temperature and time controls, automatic regulation, recording instrumentation and car loading.

GRINNELL COMPANY, INC. Providence 1, R. I.
Branch warehouses in principal cities.
Pipe Fabrication Plants: Cranston, R. I.; Warren, Ohio.

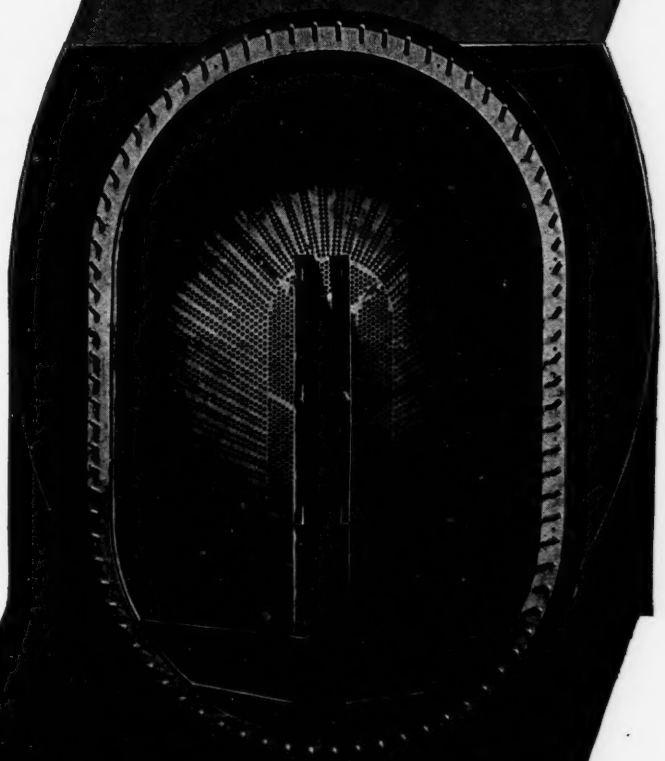
GRINNELL
WHENEVER PIPING IS INVOLVED

The Trinidad Station is the base load station of the Texas Power and Light Company which gives uninterrupted service to industrial, commercial, and residential consumers over an area of approximately 47,000 square miles. Four Foster Wheeler condensers are installed here. A fifth, almost twice the size of the one shown on the opposite page, is now being built to serve the station's newest and largest turbo-generator. With this new turbo-generator, Trinidad will have a capability of 241,000 horsepower, enough to supply the power and light needs of a city of 1,000,000 in population.

continuous operation
and performance
over a wide range
of duty..."

Foster Wheeler Condensers Meet Specifications

That is why the Texas Power and Light Company purchased another Foster Wheeler condenser for its Trinidad Station.

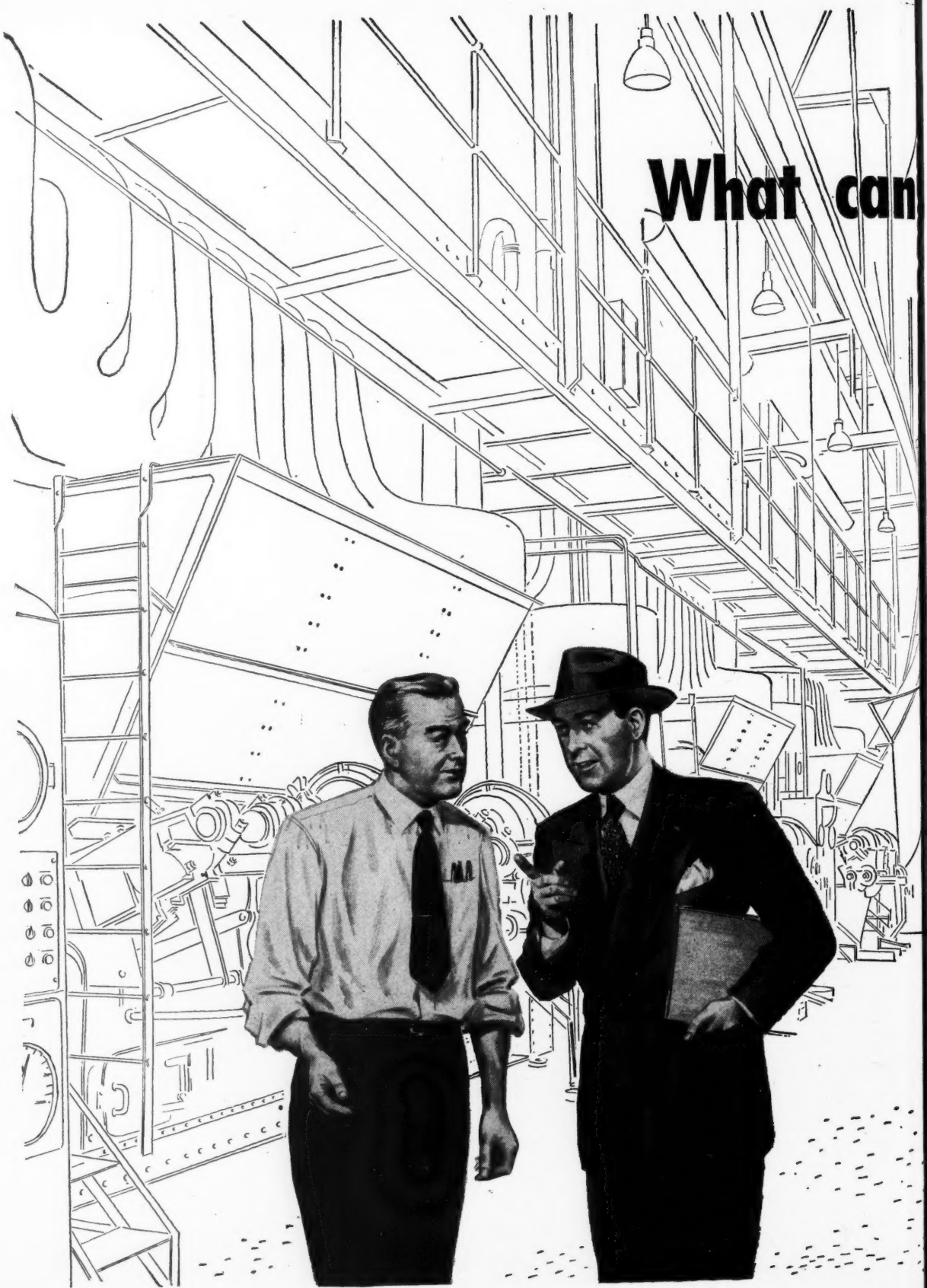


No. 4 Unit at Trinidad—28,000 sq. ft.—serving a 40,000 kw turbine

This cross-flow condenser was installed at the Trinidad Station a few years ago. It is a single-pass, non-divided water box unit. Auxiliary equipment includes a twin steam jet air ejector, two condensate pumps, and two circulating pumps.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK

FOSTER WHEELER



What can a

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can an "outsider" know about your boiler problems?

You naturally feel that you know more about your boilers than anyone else—but nevertheless Hall representatives have certain advantages that you can use to *your* advantage.

In the first place, Hall engineers have *specialized* training. They have had to make an intensive study of water and the many impurities that may be found in it; just what happens in a boiler when various types of water are used under different conditions; how to treat boiler water to prevent troubles; and, when troubles do arise, how to recognize them and trace them to their source.

They have *broad experience.* Each Hall engineer is familiar with hundreds of boilers, is constantly visiting dozens of plants and knows these plants intimately. A troublesome condition may be new to you — but the chances are 100 to 1 that your Hall engineer has already met the same situation elsewhere and knows what to do about it.

Finally, Hall engineers are not working alone. They have the cooperation of the whole Hall organization—which means the accumulated experience of more than 25 years of boiler water conditioning, *plus* laboratory facilities and personnel which are unsurpassed in this field, *plus* a program of continuing research which keeps this organization ready to meet every new requirement.

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

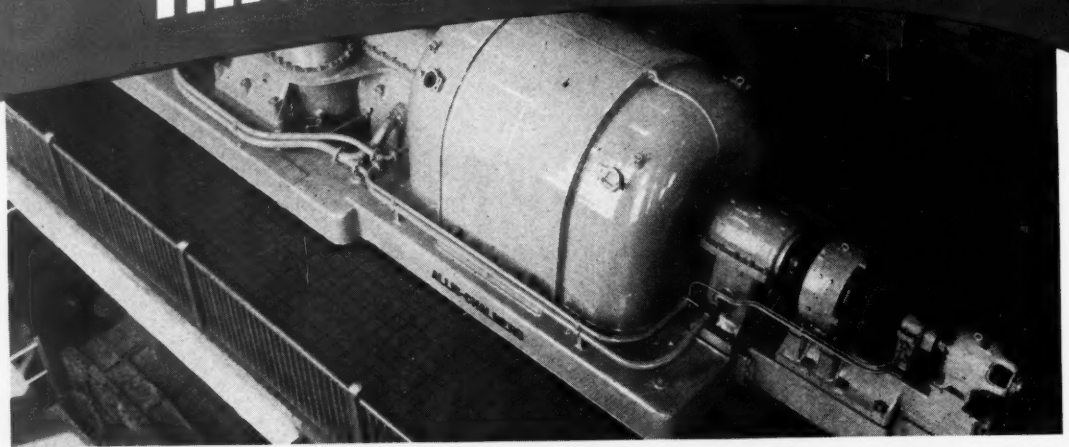
HAGAN
HALL
BUROMIN
CALGON

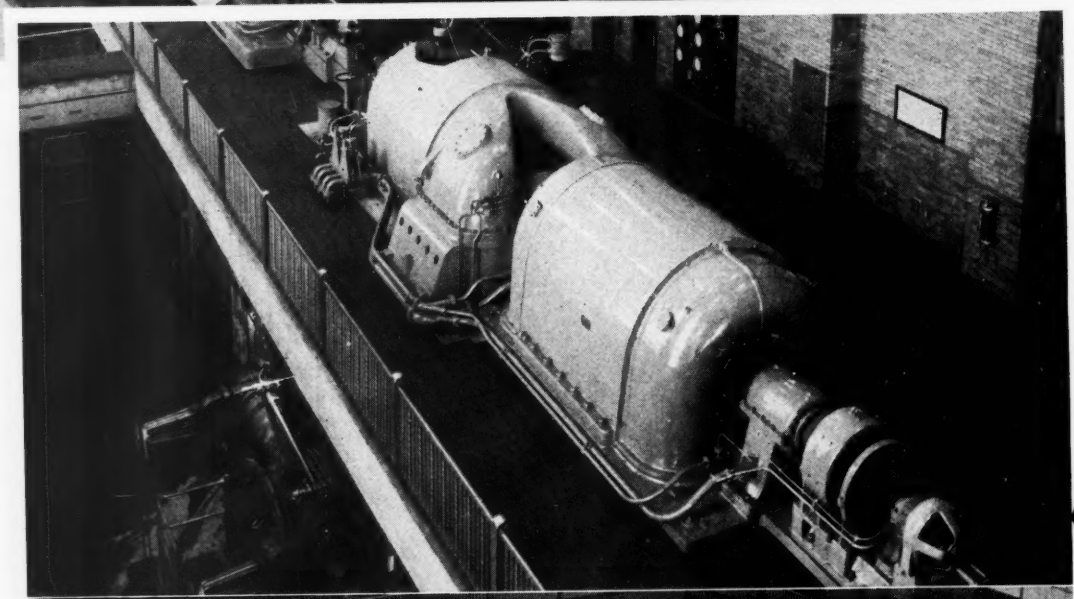
HALL LABORATORIES, INC.

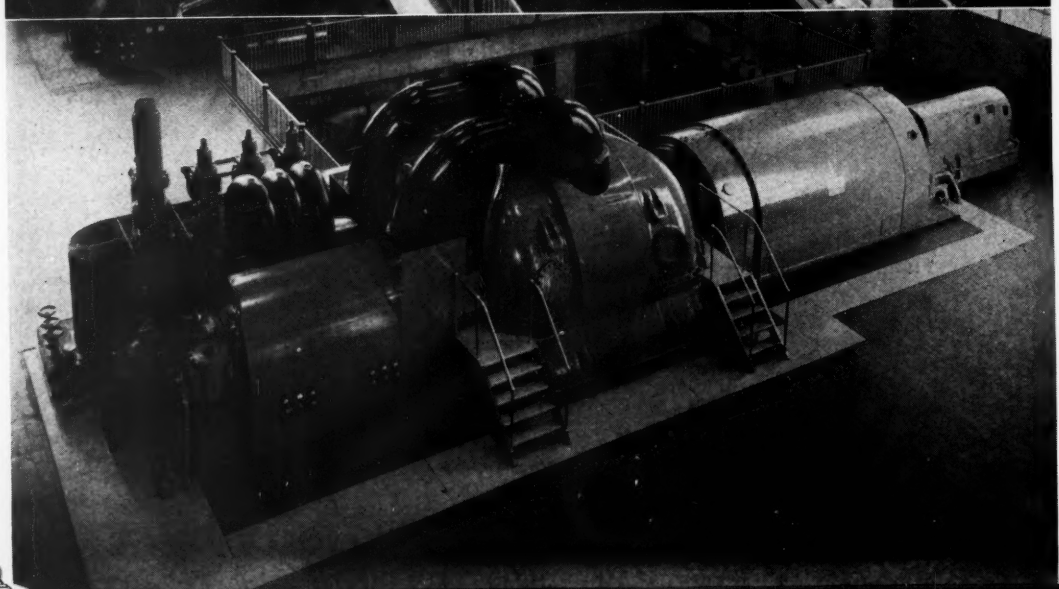
(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

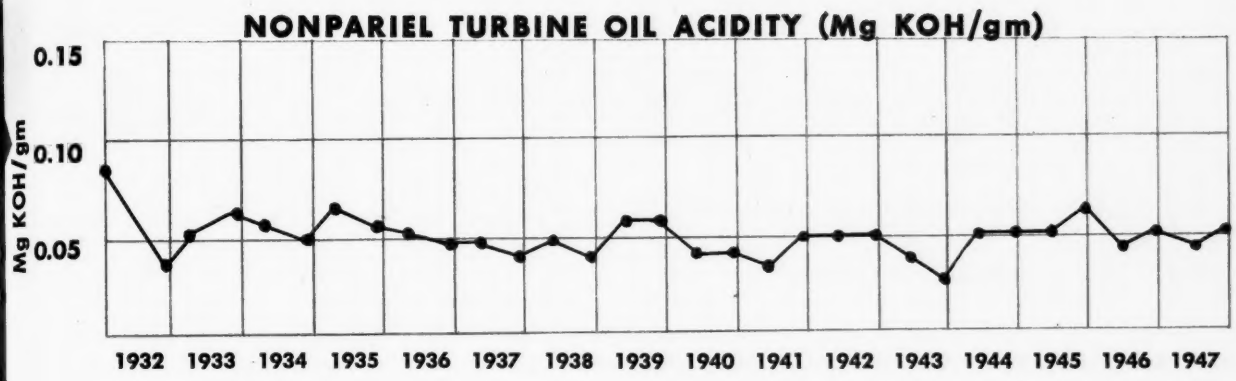
this 16-year record







STANDARD OIL COMPANY (INDIANA)



. . . of low acidity puts NONPAREIL TURBINE OIL into these two units

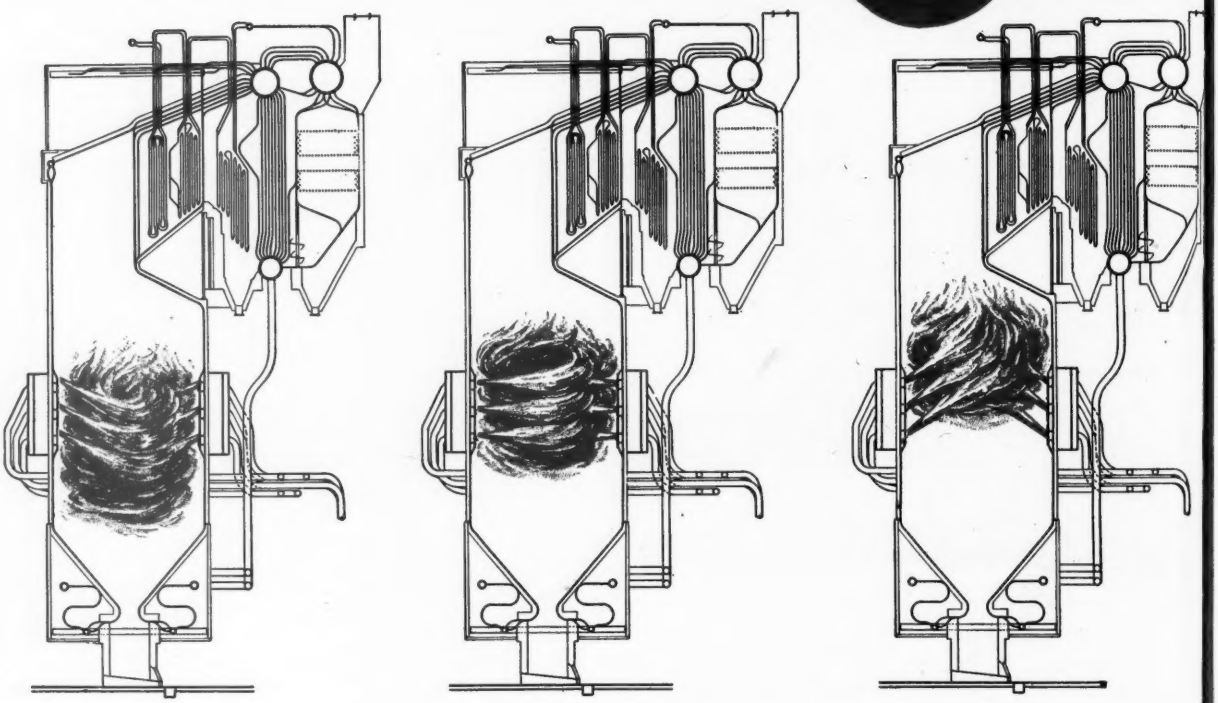
cidity always very low . . . oil never taken out for eating . . . oil system never in need of cleaning . . . rbine never shut down for lubrication trouble of any ind! That's the 16-year record of Nonpareil Turbine il in a 7500 KW unit of a midwest power plant. And 's the record that was responsible for putting Non-areil into units of 12,500 KW and 20,000 KW in the me plant.

When you use Nonpareil, low acidity is so certain at we give you a written guarantee that the oil will ot "increase in acidity above 0.15 mg KOH/gm." This guarantee is your insurance against outages caused by oil failures.

And, if you are installing a new turbine, Nonpareil will help you reduce your investment. It eliminates the need for extra batches of oil and auxiliary equipment for oil treating, such as tanks, pumps, and piping. A Standard Oil Lubrication Engineer can give you all the facts. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois for the engineer nearest you.

NA) STANDARD OIL COMPANY (INDIANA) STANDARD

The ABC of Co



THE ILLUSTRATIONS ON THIS PAGE SHOW how the flame body can be raised or lowered over a considerable distance to make use of more or less furnace heat absorption surface and thereby effect wide range control over the gas temperatures leaving the furnace. Since Vertically-Adjustable Burners provide control of furnace heat absorption in the same manner that would be accomplished by the ability to increase or decrease the size of the furnace at will, they provide, in effect, an "adjustable furnace."

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS. ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

Constant Superheat

(Adjustable Burner Control)

As simple and fundamental as ABC is the idea of maintaining constant superheat by controlling gas temperatures leaving the furnace. And **A**djustable **B**urner **C**ontrol . . . as provided by C-E Vertically-Adjustable Tangential Burners . . . is the one proven method of controlling gas temperatures leaving the furnace.

With C-E Vertically-Adjustable Burners, furnace heat absorption can be regulated to produce a considerable variation in the temperature of furnace gases entering the superheater. Thus it is possible to compensate for wide differences in operating conditions — load, fuel and furnace cleanliness — and obtain whatever gas temperature at the top of the furnace may be required to maintain virtually constant superheat temperature. Such results under either push-button or fully automatic control are a matter of record in a number of installations.

Industry-wide acceptance of **A**djustable **B**urner **C**ontrol . . . as a practical and reliable answer to the superheat control problem . . . is evident from the fact that cumulative kilowatt capacity, equipped or on order, has passed the 5½ million mark, and — with the exception of restrictive war years — has averaged well over a million kilowatts a year.

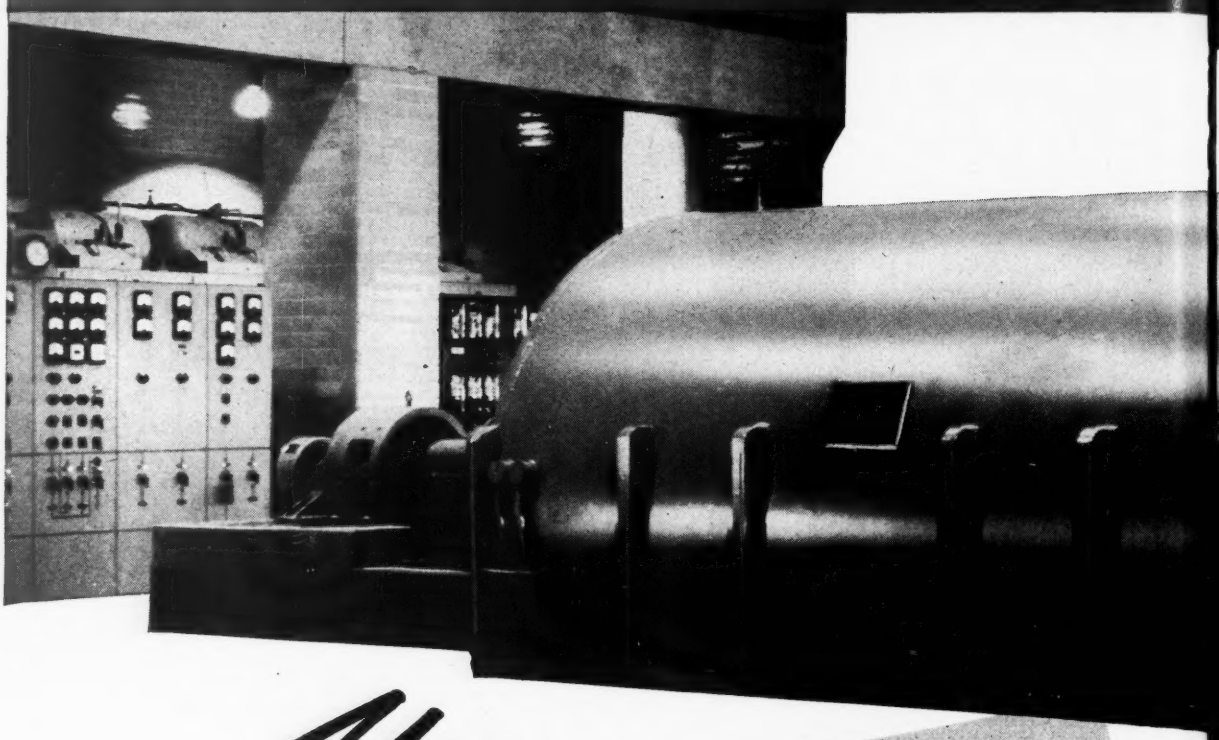
B-226

C-E

ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

TURBINES MUST



...Use

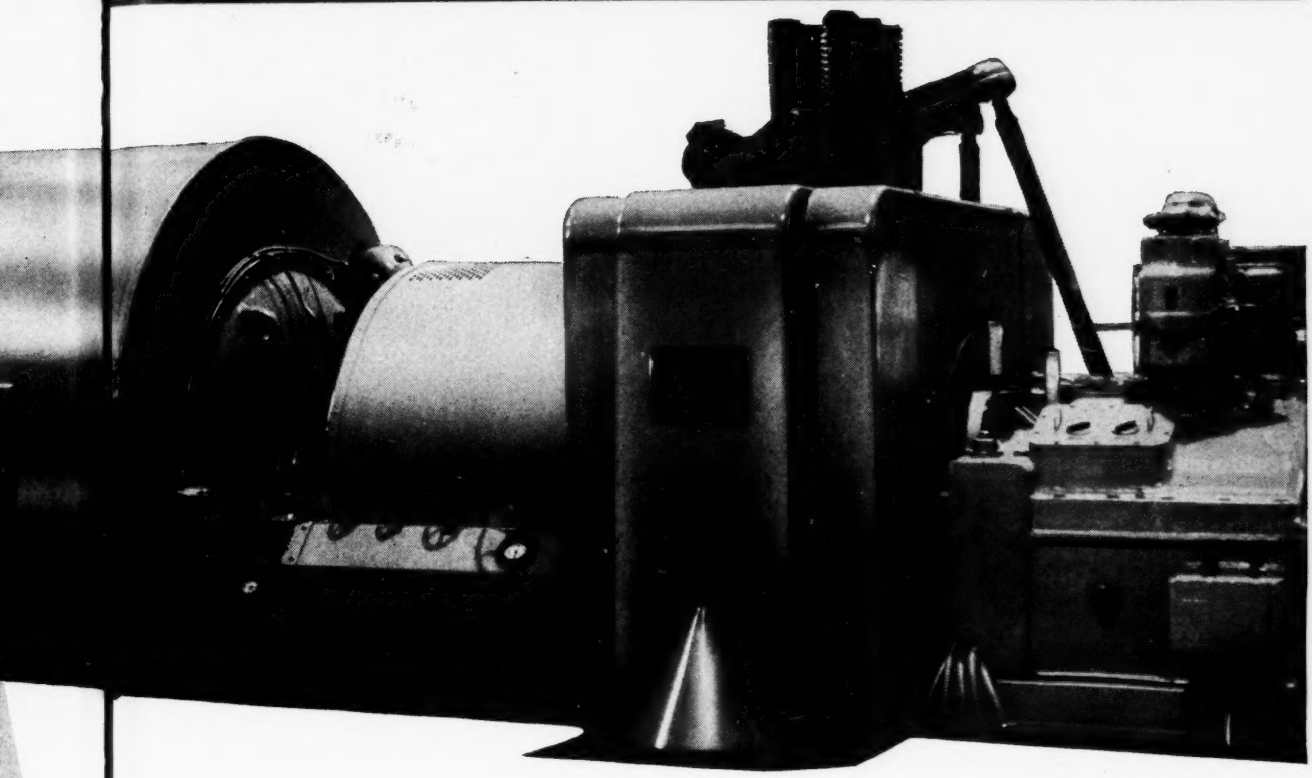
SINTURLITE OIL

Time out needed for cleaning or changing turbine oil is greatly reduced when Sinclair SINTURLITE is the lubricant. With SINTURLITE OIL on the job the circulating oil flows freely...continuously...keeps new oil qualities and delivers full lubricating value year in and year out.

SINCLAIR

YOUR NEAREST SINCLAIR AGENT WILL GLADLY ARRANGE

BE KEPT GOING



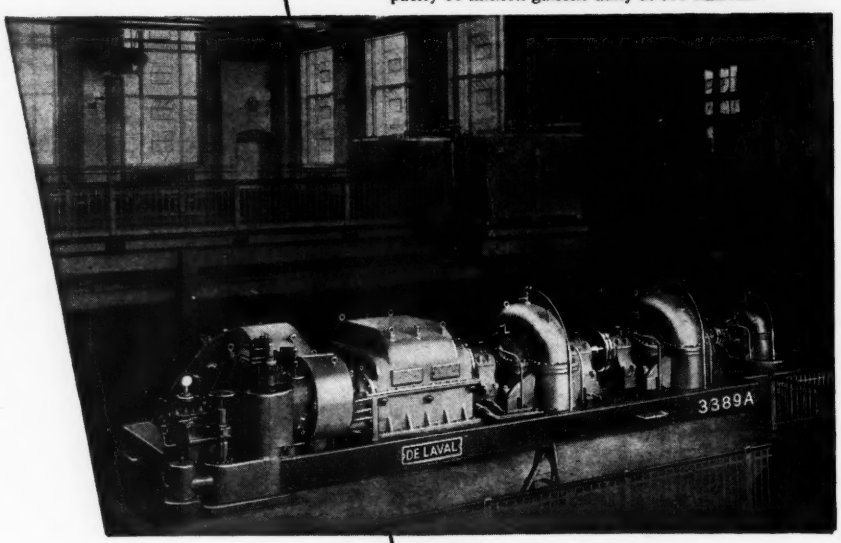
Sinclair SINTURLITE OILS have set an enviable performance record for standing up in the grueling day in and day out grind of continuous turbine service. SINTURLITE'S inherent high oxidation stability is strengthened by proven additives. Sludge formation and acid value are checked. Protection against rust trouble is assured because SINTURLITE OILS are rust inhibited. All the lubricating requirements prescribed by the turbine builders are provided by SINTURLITE—with margins to spare. Try SINTURLITE in your turbines.

INDUSTRIAL OILS

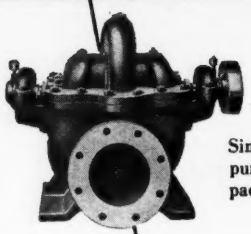
FOR LUBRICATION COUNSEL, OR YOU MAY WRITE TO SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

Different in SIZE

A 4500 hp, geared turbine-driven pump. Capacity 60 million gallons daily at 360 ft. head.



Alike in QUALITY



Single-Stage, Double-Suction pump for relatively small capacities and moderate heads.

The upper photograph shows a De Laval 4500 hp geared turbine driven pump having a capacity of 60 million gallons daily at 360 ft. head. The small pump is a De Laval Double-Suction, Single-Stage Unit having a capacity of 200 gallons per minute at a head of 100 feet.

Both are designed with the same care by the same engineers. Both are built in the same shops to the same quality standards. Both are equipped with such quality features as renewable labyrinth wearing rings for high efficiency over long periods of use.

De Laval Centrifugal Pumps are built in an extremely wide range of sizes and capacities for practically every fluid handling service.

When writing, state your requirements so that we may give you prompt attention by mail or personal call.

Atlanta • Philadelphia • Los Angeles
Chicago • Pittsburgh • San Francisco
St. Paul • Cleveland • Tulsa • Boston
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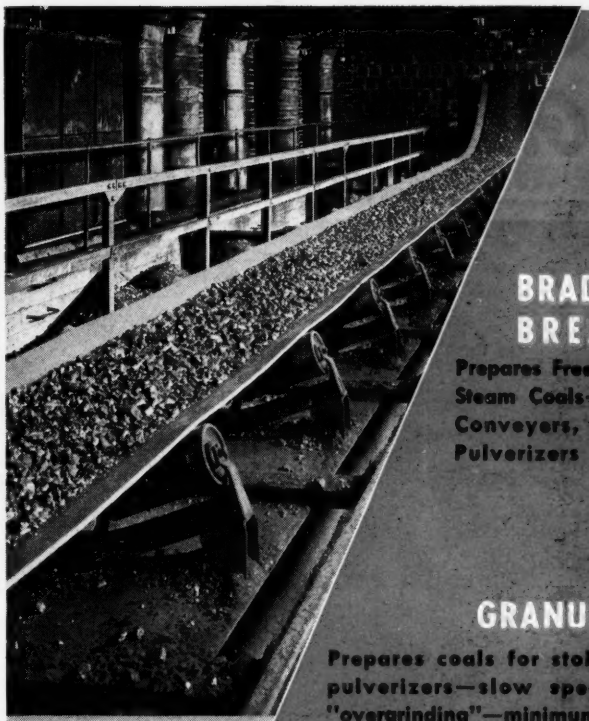
DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J. GP-4

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS



Typical "Pennsylvania" Bradford Breaker prepared coal, just as it came from the breaker at a Central Station installation. (Unretouched photograph.) Uniform, no oversize, minimum fines.

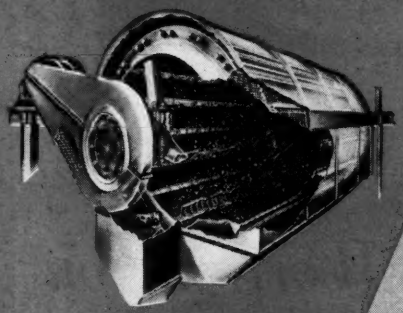
"PENNSYLVANIA STEELBUILT

CRUSHERS

FOR CENTRAL STATIONS AND INDUSTRIAL POWER PLANTS

BRADFORD BREAKER

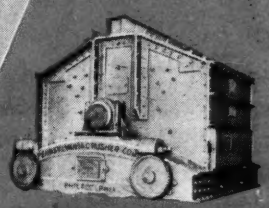
Prepares Free-Flowing Steam Coals—Protects Conveyers, Stokers, Pulverizers



GRANULATOR

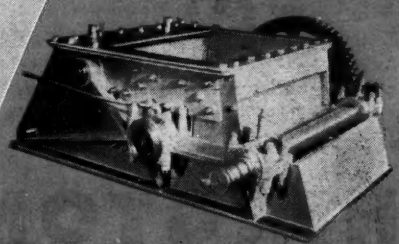
Prepares coals for stokers and pulverizers—slow speed, less "overgrinding"—minimum dusting—low maintenance and power

Typical pile of tramp iron and other refuse removed automatically from coal during preparation by Bradford Breaker.



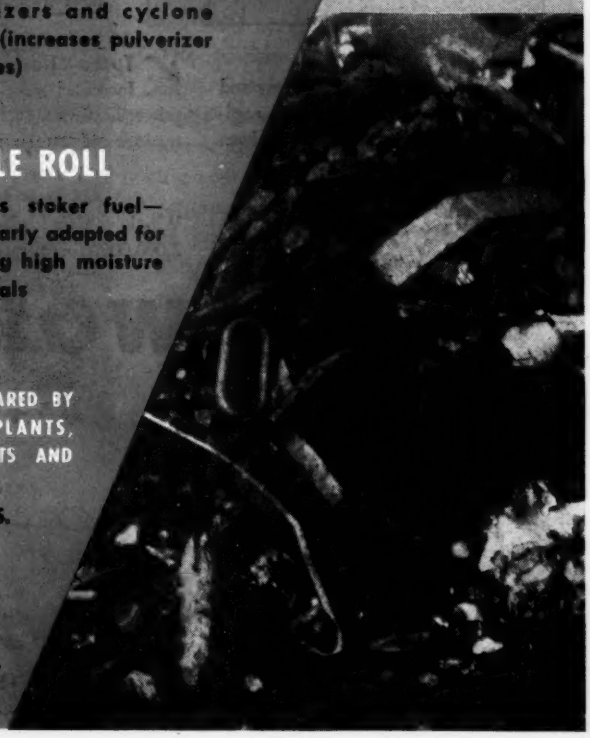
REVERSIBLE HAMMERMILL

Fine sizing of coal for pulverizers and cyclone burners (increases pulverizer capacities)



SINGLE ROLL

Prepares stoker fuel—particularly adapted for handling high moisture strip coals



OVER 300,000,000 TONS OF COAL PER YEAR ARE PREPARED BY "PENNSYLVANIA" CRUSHERS IN MINES, CLEANING PLANTS, BY-PRODUCT COKE PLANTS, INDUSTRIAL POWER PLANTS AND CENTRAL STATIONS.

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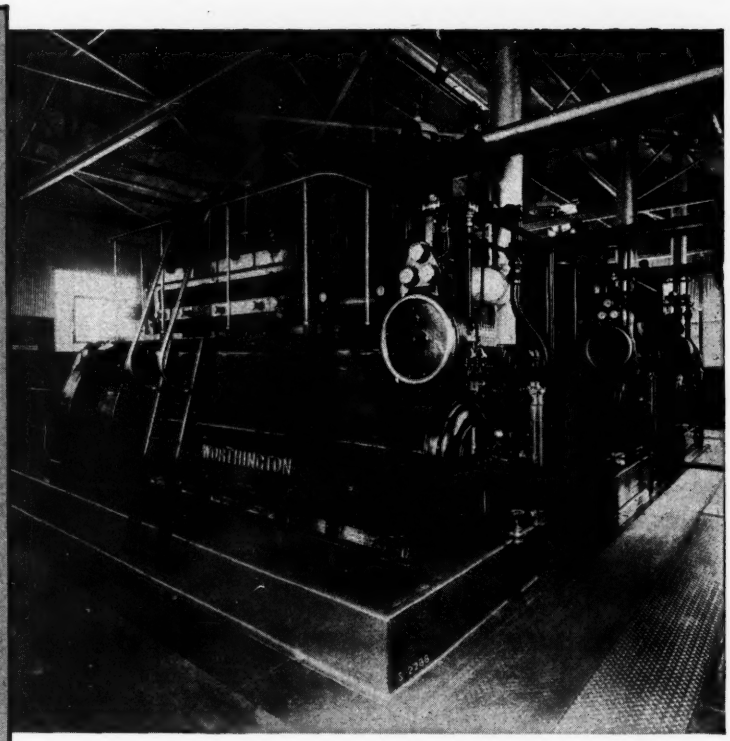
BEFORE YOU BUY A
DIESEL OR GAS ENGINE

Check These Worthington Features Approved by Power-Wise Purchasers



Three Worthington CCG-6 Engines Serving The Continental Oil Co., Griffin, Indiana

✔ **Four-Cycle Design**
. . . The sustained high economy and dependability of this design, as engineered by Worthington, have been proved beyond question.

✔ **Rugged Construction**
. . . Rigid enbloc frame, large crankshaft, four-bolt main and connecting rod bearings and gear-driven camshaft assure extra-long service life.

✔ **Trouble-Free Operation**
. . . Conservative ratings, full force-feed lubrication, total enclosure and controlled cooling are typical Worthington features for safety-plus reliability.

✔ **Turbo-Charging (Available)**
. . . Increased efficiency and more power in the same space cut fuel, maintenance and installation costs.

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Which explains why there are over 2,000,000 Worthington Diesel and gas engine hp now in service, in every part of the world . . . and why *there's more worth in Worthington.* Get this complete story of how gas or oil fuel can be converted into maximum power at lowest cost. Write to *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

WORTHINGTON

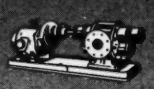
E7-3

YOUR PARTNER IN POWER PROGRESS

Diesel engines, 150 to 3,520 hp . . . gas engines, 175 to 3,290 hp . . . dual fuel Diesel engines, 225 to 3,290 hp.

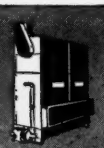
WORTHINGTON-BUILT AUXILIARIES

Air King Compressors



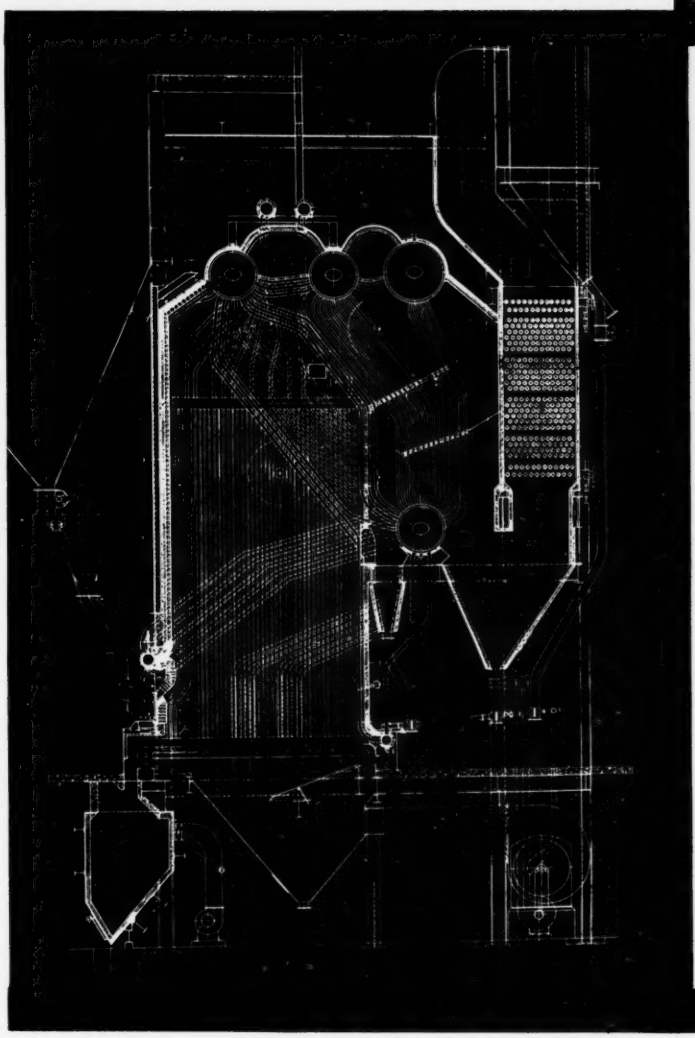
Oil Transfer Pumps

Cooling Water Circulating Pumps



Evaporative Type Engine Water Cooler

Another WICKES BOILER for Morton Salt Company



When engineers of the Morton Salt Company specified a Wickes 4-Drum Boiler for the Morton plant at Manistee, Michigan, their choice was dictated in part by proven Wickes performance. For this is the *second Wickes boiler* installed at Morton's Manistee plant—evidence that *Wickes design and construction delivers the efficiency* that industry demands of a power generating unit. Cummins & Barnard, Inc., Engineers, of Ann Arbor, Michigan were consulting engineers on this installation. Specifications include: 180,000# steam per hour capacity, design pressure 700 psi, and total temperature 750° F. The advantages of Wickes 4-Drum Boiler design are readily apparent. Large diameter drums, minimum number of tube bends, and steam liberating area large enough to insure *rapid response to load changes.* For boilers of any type with capacities up to 250,000 lb. steam per hour and 850 psi, *consult Wickes first.* We are completely equipped to design and build boilers to specific requirements.

THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

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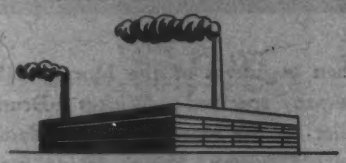

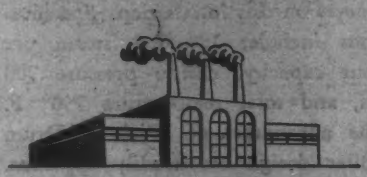

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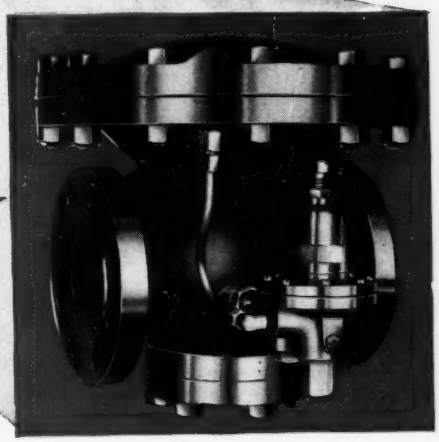
THE FISHER "WORKHORSE"
FOR STEAM PRESSURE REDUCTION

BUILT FOR UNFAILING SERVICE

Power engineers everywhere have ok'd the Fisher Type 92 for steam pressure control! It's an accurate, compact, flexible, sturdy controller, designed, built and proved to meet the most exacting requirements for steam service.



TYPE 92

PILOT OPERATED CONTROL VALVE

SINGLE SEATED • TIGHT CLOSURE

The single seated construction assures tight closure and prevents excessive pressure build-up. Reduced pressure ranges 3-200 PSI. Inlet pressure up to 250 PSI at 450°F.

Fisher Bulletin C-2A gives full details. Write for your copy today.

ACCURATE

Pilot control — with its extreme sensitivity to flow changes — maintains the desired reduced pressure with remarkable accuracy. No auxiliary pilot operating medium is needed.

COMPACT

Modern Fisher Engineering has produced in the Type 92 Valve a compact controller with unusually large capacity. Available in 10 sizes from ½" to 2" screwed or 1" to 6" flanged. No special wrenches are required for servicing.

FLEXIBLE

Two pilot assemblies for high or low pressure service are available and interchangeable on all Type 92 sizes. Pilot control spring easily adjusted or changed to obtain a variety of reduced pressure ranges.

STURDY

High-tensile bodies and diaphragm casings are of extremely rugged, ribbed construction. Inner parts are of Duromite bronze or stainless steel—or special material as ordered. Every construction detail designed to assure maximum trouble-free service.

Fisher Governor Company

1039 FISHER BUILDING

Marshalltown, Iowa

NEW

Nalcometer

New Features . . .

- *4 wide ranges,* for accurate measurement of dissolved solids from 0.4 parts per million to 1,000 grains per gallon.
- *Direct-reading*—no charts, scales or calculations.
- *Exclusive patented electrodes* do not require re-platinumizing.
- *Compact* . . . measures only 3¾" x 8" x 8" overall.
- *Rugged* . . . Stainless steel case houses shock-mounted internal mechanism.
- *AC or DC operation* . . . Either plug into 110 V. light socket, or operate on self-contained batteries.
- *Dependable* stabilized circuit and automatic temperature compensation assure accurate readings and long, useful service.

*U*SING the new Nalcometer is literally as simple as a flick of the wrist! You can make accurate dissolved solids determinations faster than an assistant can fill test beakers!

This is a simplified, dependable precision instrument in work clothes. Years of continuous use are built in — And operation on either AC or DC current is the low-cost way to *know* what your dissolved solids concentrations are at all times.

Write Nalco today for complete details on the new Nalcometer for your water treatment control.

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. . . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

BOILERS AND ACCESSORIES

1 **Pulp Industry Steam Generators**—Bulletin 11-48 pages, describes the types of steam generators and stokers installed by the pulp and paper industries. Tables, bar graphs, and cross sectional views of typical units illustrate the number of different types of units and their auxiliaries. Fairmont Coal Bureau.

2 **Recent Boiler Design Practice**—Bulletin 3-407 — 24-page booklet of a paper presented at an ASME meeting on the recent boiler design practices. The booklet is complete with tables, charts, sectional drawings of tubes, insulation on boilers, heat flow diagrams, combustion chambers, economizers, boiler layout construction, various applications, pulverized fuel firing methods, construction of economizers, flow drawings, phantom views of complete boiler units. Babcock & Wilcox Company.

3 **Mechanical Draft Cooling Towers**—Bulletin 36, 4 pages, describes recent design changes in the type 2K-S spray-filled induced draft cooling tower. A plan view is given showing the distribution of the framing and the valve. Also three plan views are given showing the actual construction of the framing. The nozzles used in the tower are also illustrated. Information table with capacity sizes and weights on the steel cased induced draft cooling tower is provided. A handy table of 2K-S tower sizes and capacities based upon the use of the tower at 10 F cooling range and with bulb conditions is given. Binks Mfg. Co.

4 **Water Tube Steel Heating Boilers**—This 8 page bulletin explains these boilers and their use with various firing methods. Gas flow diagrams are presented. Sketches and photos explain the construction. Steam rating for mechanical firing is 2680 to 42,500. International Boiler Works Co.

5 **Heating Controls**—Catalog F-99, 28 pages utilizes equipment cutaway photos and drawings with charts, specification tables, to show the construction, installation and application of the many different types of controls in valves, heaters, tankless heaters and converters made by this firm. Many different installation diagrams plus capacity tables on the heaters are given. Taco Heaters, Inc.

6 **Worm Feed, Side Dump Stokers**—Bulletin No. 500, describes and illustrates in 8 pages the stokers made by this firm. Application photos, dimensional drawings, cross-sectional drawings, and photos of the worm and gear mechanism help explain the construction and operation. Canton Stoker Corp.

7 **Gas Burner**—Bulletin SP1, 4 pages, describes and explains these ready to be installed gas burners. The several sizes available with their attendant Btu ratings are shown. A sketch showing method of installation is given. B. P. Lientz & Co.

8 **Electrode Steam Boiler**—Bulletin T-9, 4 pages, describes the small electric steam boilers and their operation. The balanced controls are discussed and pointed out in 2 cross-sectional drawings. Four standard models are available. Livingstone Engineering Co.

9 **Industrial Insulation**—Form No. A-91, 24 pages, illustrates typical applications of the products of this firm. Tables, charts, application data, and descriptions of each product and its uses are given. Specifications provided. Thermal conductivity table of various materials, losses from flat iron surfaces, vertical iron surfaces, and iron pipe are given as well as effect of windage. Eagle-Picher Co.

10 **Soot Remover**—This 2 page catalog sheet explains the product of this firm for removing soot. Product is a chemical which when introduced into the fire box gives off a white gas that is said to do the work of loosening the soot. RX Chemical Co.

ELECTRICAL

11 **Continuously Adjustable Transformers**—Form 424-H, 8 pages, describes the continuously adjustable transformers made by this firm for industrial use. Charts, tables, dimensional drawings, specifications, highlight photos of construction, and the various wiring diagrams suitable for these transformers. General Radio Co.

12 **Electrical Equipment** — Catalog No. 48-A, 16 pages, discusses and specifies the various types of lightning arresters, gas relays, terminal strip, potheads and other electrical equipment made by this firm. Photos, wire sketches, and dimensional drawings, illustrate the equipment offered. L. S. Brach Mfg., Corp.

13 **Dry-Type Transformers**—Booklet B-4009 describes with cut-away photographs and charts dry-type transformers. These transformers are suitable for 120-140 v covering standard range, standard rating from 0.025 to 2,500 kva single phase and 9 to 3,750 kva, three-phase. Westinghouse Electric Corp.

14 **Electrical Line Connectors**—Bulletin No. 48Y1 — 8 pages, depicts with blown up drawings, sketches, photos of equipment, dimensional tables, charts of sizes, types, connectors available and the tools for applying the connectors to the line. The connectors are said to be beryllium-copper lined for low resistance. Burndy Engineering Company, Inc.

15 **Electrical Conduit**—Bulletin 351, 64 pages, describes and illustrates the process that conduit goes through in manufacture. A 37 page section has handy reference material and tables for electrical users of conduit. Electrical data, definitions of terms, symbols, computing conductor sizes, and other information is provided. Spang-Chalfant Div., National Supply Co.

VALVES

16 **Salt Water Disposal Valves**—This 4 page bulletin describes the applications to which these valves are suitable. The sizes and type of connections with working pressure are given in a specification table. Black, Sivalls & Bryson, Inc.

17 **Plumbers and Steamfitters Packing**—This 2 page fold out sheet describes the packing made by this firm for use on plumbing fixtures and explains its use by the steam fitter. Photos and sketches are used to depict the application. Flexrock Co.

18 **Heavy Duty Steam Valves**—Bulletin 8-B — 28 pages, pictures and describes this line of boiler stop valves, check valves, stop check valves and triple duty valves for medium and high pressure service from 250 to 2100 lbs, and temperatures up to 1150 F. Information is given on the construction, parts and materials that are used to manufacture these valves in addition to dimension and performance data. Schutte and Koerting Company.

19 **Diaphgram Valves**—Bulletin No. V-47 utilizes exploded drawings, cut-away photographs, maintenance photos and flow sketches. To show the use of these valves and their construction. Application photos are provided as well as specifications, tables of dimensions, and sizes available along with dimensional drawings provided for the selection of valves for various jobs, hand operated model, lever operated model, sliding stem model, and four air operated models make up the contents of the book. Hills-McCanna Co.

20 **Non-lubricated Ball Valve**—Bulletin K-48, 4 pages depicts with exploded views, flow diagrams, construction and operation of the ball type valves made by this firm. Color is used in all the photos and drawings. Additional drawings and table of available sizes is provided. Kerotest Mfg. Co.

21 **Multi-port Relief Valves**—Publication 4150, 28 pages, depicts with equipment photos, charts, cut-away drawings, hook-up sketches, the multi-port valves made by this firm for use as relief valves for air, steam, and blast furnaces. Parts photos show the valves and springs which make up these multi-port valves, Sizing data tables on the valves are given. Cochrane Corp.

PUMPS

22 **Double Suction Centrifugal Pumps**—Catalog No. A1147, 20 pages, explains the operation and construction of these pumps and discusses performance. Tables of selection and specifications are provided. Charts are used to show the performance that may be expected. Economy Pumps, Inc.

23 **Condensate Return Units**—Bulletin 201 — 6 pages, depicts with equipment photos and photos of various controls from component parts of the unit, the construction and assembly of these package condensate return units. Tables of capacities for various applications are given. Tables of water required per min. to feed boiler per hp are given. Roy E. Roth Company.

PIPE, TUBING AND FITTINGS

24 **Supplement to Engineering Data Book**—Supplement No. 111 has 20 pages and is devoted to specifications of several new items on the subject of welding fittings and flanges for industrial piping. Tube Turns, Inc.

25 **Flexible Metal Hose**—Catalog No. 113 — 24 page booklet describing and illustrating the flexible metal tubing made by this firm. Tables are given for

JULY, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

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sizes and recommended pressures. Dimensional tables are presented for standard pipe fitting, flared tube fittings and inverted flared tube fittings also compression tube fittings. 2 pages are devoted to typical assembly for industrial pipe fittings and typical assemblies with SAE fittings. Titeflex, Inc.

26 **Flexible Exhaust Tubing** — This pocket size 6 page folder, describes with photos the types of flexible exhaust tubing offered. Many sketches show the various applications the tubing finds in different industries. American Ventilating Hose Co.

27 **Cold Forged Steel Unions**—Bulletin U602, 4 pages, presents with cross-sectional views and tables the unions made by this firm. Available with silicon bronze, stainless steel, moly steel seats and with speed threads or socket-weld joints. Rockwood Sprinkler Co.

28 **Pipe and Fin Coil Engineering Data Book** — This 36 page engineering data book was prepared for the engineer and draftsman as a guide in the design of pipe and fin coils, with specific data on the subjects of dimensional limitations, coil development formula and heat transfer factors. Rempe Co.

29 **Color Scheme for Piping Identification**—This 4 page folder will be of value to the man who has to set up a color scheme for quick identification of piping. Presents possible color codes to be followed for piping in these services: fire protection, steam, water, compressed air, combustibles and lubricants, and miscellaneous. Sizes of lettering are recommended, and a typical application is shown for clarification. Rust-Oleum Corporation.

30 **Welded Ball and Cylindrical Floats**—Bulletin No. 348, 8 pages, features welded floats of stainless steel, Monel, and chrome plated steel, in spherical, elliptical and cylindrical shapes with price list, weights, buoyancies, and collapsing pressures and other information. W. H. Nicholson & Co.

INSTRUMENTS AND CONTROLS

31 **Water Treatment Feeders**—Bulletin No. 844112, 6 pages, complete with actual installation photographs showing the feeders in operation. Feeders of three sizes and capacities are described and shown. One page tells how to use the feeders. Calgon, Inc.

32 **Electronic Level, Pressure, and Temperature Control**—Catalog No. 27, 8 pages, describes the relay made by this firm that may be used for liquid level and interface control and alarm, pressure and flow, temperature, and high foam control and alarm. Types, specifications, and list prices are given. R-S Products Corp.

33 **Construction Materials for Flow Measuring Instruments**—Bulletin No. 10003, 4 pages, is a listing of the recommended materials to be used in the flow measuring instruments made by this firm. The fluid to be measured and the materials for fittings, float, and packing are given in that order. Special list of substitute materials is given for those parts that must be cast. Fischer & Porter Co.

34 **Combustion Controls**—Form 5067 is a 2 page catalog section showing the several combustion controls made by this firm. The purpose of each control is described and explained. Perfex Corp.

35 **Stop Watches**—Bulletin No. 576, 4 pages, describes and illustrates the stop watches and chronographs made by this firm in both pocket and wrist styles. Essential information on each instrument is offered. These are 1/5, 1/10, and 1/100 sec timers. Decimal timers also offered. Herman H. Sticht Co., Inc.

36 **Flue Gas Analyzer**—Bulletin No. 1136A, 4 pages, details the effect stack gases have on combustion efficiency of fuel. It explains how the new unit analyzes the composite of the stack gases and indicates deviations from the ideal. Photos and schematic drawings show details of analyzer. Davis Emergency Equipment Co., Instrument Div.

MECHANICAL POWER TRANSMISSION

37 **Geared Motor Power Drive**—Form F-1498, 16 pages, utilizes equipment and phantom views in color to explain the construction of the single reduction gear motors and the double reduction variable speed gear motor drive offered. Color shows the methods used in construction. U. S. Electrical Motors, Inc.

38 **Hydraulic Torque Converters** — Bulletin No. 135-B, 16 pages, describes the Models F and CF made by this firm. Phantom views, parts photos, cross-sectional and dimensional drawings, tables, and equipment photos explain the construction and operation of the torque converters. Twin Disc Clutch Co.

39 **Variable Speed Reducers**—Bulletin WT 4-48, 4 pages, describes the transmissions and variable speed reducers for machine tool and other industrial applications made by this firm. Reduction ratios, hp capacities, and types of mounting are given. Western Mfg. Co.

40 **Flexible Couplings** — Catalog C 41-48, 32 pages, describes and explains the construction and operation of these flexible couplings by means of exploded views, drawings that depict effect of strains and stresses imposed by misalignment, dimensional and cross-sectional drawings, and tables of specifications. Torsional deflection charts are also provided. Morse Chain Co.

41 **Flexible Couplings** — Catalog 48, 24 pages, describes and explains with photos, sketches, and dimensional drawings the construction and application of these flexible couplings. Size and dimensional tables are given for each type. Ajax Flexible Coupling Co., Inc.

42 **Variable Speed Selector**—Bulletin 8-7531 GI, 4 pages, describes the operation of the speed selector. Photos show positions of V-belt at various speeds, and several applications. A dimensional drawing with accompanying table is given. Horsepower and torque rating tables are provided for each of the 3 models. B. F. Goodrich Co.

43 **Transmission Belt Maintenance**—This 16-page bulletin deals with the cleaning, treating and applying of belt dressing to transmission belts. The subject of de-oiling belts is discussed with the recommendation of this company. Equipment made by this firm for oiling, cleaning and de-oiling of belts and their bearings are given. Du-Grip Manufacturing Company.

TOOLS

44 **Blank Cartridge Driving Tool**—Bulletin No. TA-15, 2 pages, describes the operation and applications of this tool for driving rivets or studs or anchors, into wood, steel, concrete, or other masonry. The bulletin explains how the blank cartridge furnishes the power that does the work. Mine Safety Appliances Co.

45 **Single Unit Lock Nuts**—This 6 page pocket size folder depicts in a cross-sectional drawing the action of the locking feature. Dimensional drawings are given for types offered. An-Cor-Lox Div., Laminated Shim Co., Inc.

46 **Work Spotlights** — This 6 page folder bulletin utilizes many application photos from various industries to show how the spot lights made by this firm can be used. A table is given which shows the levels of illumination required to light work areas on various jobs. Fostoria Pressed Steel Corp.

47 **Stainless Steel Fastenings** — This 4 page bulletin is the product list of the fastenings made by this firm from stainless. Products include the standard nuts, bolts, and screws, and various pins, rivets, washers, nails, pails, sink bowls, pipe and pipe fittings. Pertinent data as to size and materials analyses are given. Anti-Corrosive Metal Products Co., Inc.

48 **Hydraulic Jacks** — Bulletin No. DN3-465-R, 4 pages, explains the construction of these hydraulic jacks with a phantom view. The several models offered are illustrated and the data pertinent to selection of the jack for the job provided. Duff-Norton Mfg., Co.

49 **Grinding Oil**—This is a 24 page pocket size booklet that explains the manner in which to select cutting oils for different materials. A standard marking system chart is provided. Tips are given for handling grinding oils. D. A. Stuart Oil Co.

50 **Grinders and Buffers** — Bulletin No. 129 G, 4 pages, depicts and describes the pedestal and bench mounted grinders and buffers. Also described is the filtering unit for returning used air to the room. Specifications are given as well as prices on the various models and sizes. Cincinnati Electrical Tool Co., Div., R. K. LeBlond Machine Tool Co.

51 **Portable Shop Cranes** — Bulletin 5M, 4 pages, describes and explains the construction and operation of these cranes, as well as showing with photos the many applications to which it is suitable. Table listing the 8 sizes available and data pertinent to each size is given. Canton Div., Hill Acme Co.

52 **Small Electric Hoists** — Bulletin 7171-A describes with cut-away drawings and installation photos small hoists made by this firm. Dimensional drawings and tables are given for the several models presented. Auxiliary equipment such as the wire, block, controller, switches, are noted and explained. Robbins & Myers, Inc.

LUBRICATION EQUIPMENT

53 **Oil Purification**—Bulletin 4-1, 8 pages, presents a case history of oil purification on the many internal combustion engines in one plant. The problems of this one plant are discussed and the solution shown. Honan-Crane Corp.

54 **Lube Oil Testing**—While Bulletin 200, 8 pages, presents the equipment for testing it also shows the step by step process to be followed for testing lube oils. Photos, drawings, and charts are used to illustrate testing. Gerin Corp.

WATER TREATMENT

55 **Water Test Manual**—This manual of 62 pages is the collection of bulletins on the water treatment methods and equipment offered by this firm. The various steps in each treatment in addition to the chemicals to be used are given and discussed in detail. Color is used in the photos to show color of reaction. Dearborn Chemical Co.

56 **Water Softeners and Dealkalizers** —Bulletin No. 2418, 12 pages, utilizes application photos, charts, bar graphs, schematic hook-up diagrams, phantom views, tables, and typical analyses of water treatment problems to explain the water softeners and dealkalizers they make. The Permutit Co.

57 **Ion Exchange Resin** — Bulletin IR-105, 8 pages, describes the synthetic resin exchanger that is produced in bead form. The physical characteristics are given as well as operational characteristics for hydrogen cycle and sodium cycle regeneration. Resinous Products and Chemical Co.

BUILDING MAINTENANCE

58 **Concrete Floor Finish**—This 4 page bulletin describes the composition and applications for which this solution of inert synthetic resins is suitable. Product may also be applied to wood or steel. Application instructions are provided. Nukem Products Corp.

59 **Corrosion Preventive Coating**—A 4 page bulletin describing the products of this firm include a high heat lining for stacks and chimneys, a waterproof coating for tanks storing water, soap, chlorine, brine, or other alkaline substance subject to corrosion. Plastic Steel Service.

60 **Abrasive Safety Flooring**—Bulletin FH6, 4 pages, describes the various forms in which this flooring is available and illustrates with application photos the spots in a plant where the safety flooring is applicable. Behr-Manning Div., Norton Co.

61 **Anti-Corrosive Insulating Coating** —This is a 4 page bulletin that explains the properties of this coating. The various acids it is reputed to resist are given, as well as the corrosive fumes, and alkali substances. Claimed to be suitable for application to wood, masonry, and metal structures, as well as felt, metal, and composition roofs. Service Industries.

62 **Exhaust Ventilators**—Form No. 29 is this firm's latest catalog. The roof mounted ventilators that the firm makes are described and the sizes and types available listed with the pertinent dimensions for each. Phantom views, dimensional drawings, and many application photos depict the construction and operation. Powermatic Ventilator Co.

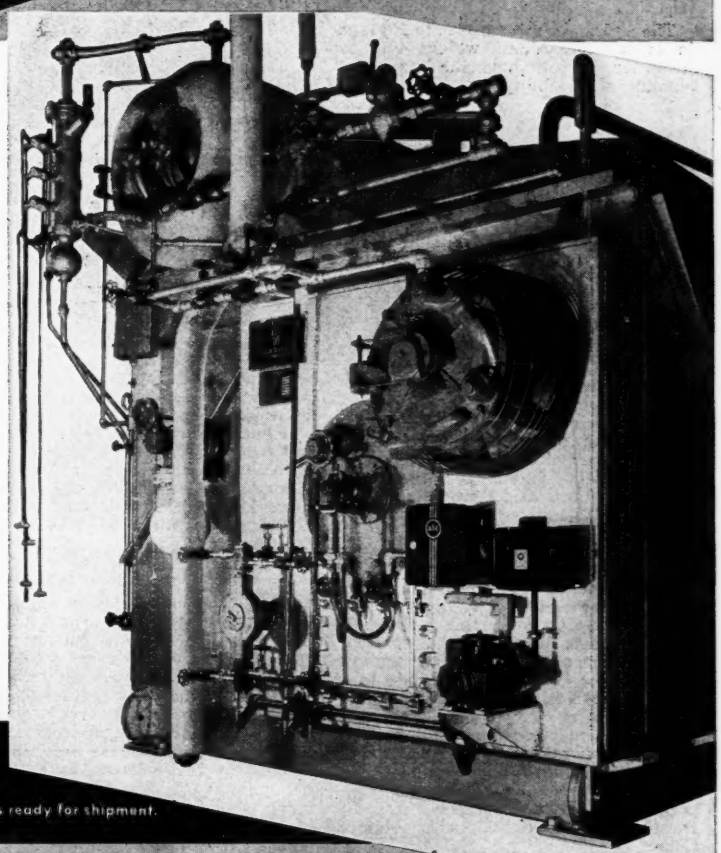
(Continued on page 94)

The NEW Foster Wheeler Package Steam Generator is...

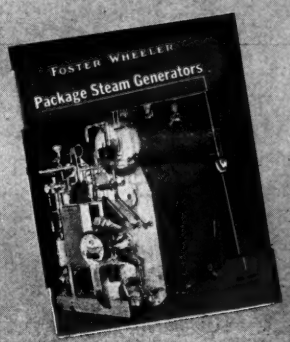
FACTORY ASSEMBLED --READY TO INSTALL

The name "package" applied to these steam generators means that all components, including burners, fans, soot blowers, feedwater regulators, combustion controls, valves, refractory, insulation and other accessories, are assembled in one package at the factory. The local labor necessary for installing this package is limited to service connections.

FOSTER WHEELER CORPORATION
165 Broadway, New York 6, N.Y.



This AG 21-0 package steam generator 21,000 lb. per hour steam capacity as shown here, is ready for shipment.



FOR
FURTHER INFORMATION
WRITE FOR
BULLETIN PG 47-17

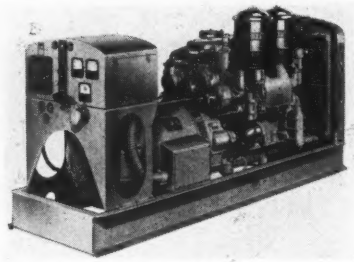
FOSTER WHEELER

NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

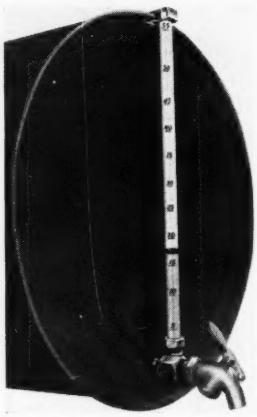
A Diesel Generator Sets. Each of these compact and completely self-contained units consists of a Series 71 Diesel engine directly connected to a single bearing generator and mounted on a fabricated structural steel base. They are offered in 2, 3, and 6 cyl sizes having continuous ratings of 20, 30, 40 and 60 kw respectively, and operate at 1200 rpm.

The 60 kw set measures only 101⅜ in in overall length and weighs 4043 lb. In order to introduce the maximum amount of flexibility into the line all



units from 20 to 60 kw have been made available with two types of cooling. The selection includes radiator cooled models which can be mounted at any height above the water line and heat exchanger equipped sets. Power generators are designed for full load continuous operation at 50 C ambient temperature and are of drip proof construction. Purchasers have single and 3 phase 60 cycle ac as well as 2 and 3 wire dc sets at standard commercial voltages to choose from in the optional equipment list. Push button electric starting is standard on all models but automatic starting and throwover equipment can be furnished where units are to operate in a standby capacity. Other items of standard equipment include air cleaner and silencer, 12 starting motor, 12 battery charging generator with regulator and automatic shutdown to prevent damage from low oil pressure, high water temperature or engine overspeed. Detroit Diesel Engine Div., General Motors Corp.

B Drum Level Gage. This drum level gage for use on oil drums features an automatic safety check valve so that in case of fire or accident to the plastic tubing, the check valve



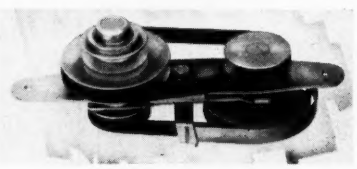
will automatically stop the flow. The plastic tube is of vinylidene chloride to withstand a wide range of chemicals. The heavy bronze T fitting has a standard tapered ¾ in. pipe thread for use with any standard drum or faucet. Tube is marked in increments of 5 gal in red numerals. A red cork float rides the liquid in the tube to indicate level. Mastercraft Products.

C Piston Valve. Now available is a cam actuated piston type valve for handling petroleum products, chemicals and other liquids. Known as the 2820 Full Flow Valve, it is especially designed for application where a positive shut-off valve is required without the quick coupling or trip proof features. The valve accommodates a 2½ in. line size and weighs only 13 lb in bronze. It is designed for a flow of 200 gpm at 25 psi. The area of the valve is said to be 20 per cent greater than the line area, thus affording no restriction to flow.

The cam is designed to allow full control of flow for loading purposes. The valve may easily be closed without hammer, or partly closed for topping off a tank. Valve closing is effected by spring action, providing a seal at static pressures. End connections are sealed with vellumoid gaskets. The main line seal may be replaced without disassembly by merely removing the retainer screw. Variations of this valve are available; for example: As a valve with a coupling on one end; as check valve; and as a 2 or 2½ in. nozzle. Roylyn, Inc.

D Small Belt Transmission. Designed to work on gasoline engines and electric motors used for loads up to 1½ hp with either a ½ in. or ⅝ in. shaft, a new belt transmission combines a clutch and speed reducer with a 3 to 1 reduction ratio. Actually two units built into one—a speed reducer and a positive working clutch—each set of two pulleys is assembled as a hinge so that when the clutch is engaged the hinge is drawn over past center causing both belts to be tight.

When the clutch is not engaged the unit "breaks" in the center and the circular guard aided by two steel fingers in the center of the unit push the inside belt entirely free from the inside pulley, allowing this pulley to continue to rotate at full engine speed. This inside pulley is firmly attached to the



engine shaft and operates independently.

To mount the tubular shaft within the unit is merely pushed on to the motor or engine shaft and made secure with an Allen head screw. Either the bottom or top of the transmission is then secured with a suitable brace and the opposite end is allowed to move freely to provide for the clutch action.

Either a vee pulley or sprocket may be furnished for the final drive. The standard sprocket now furnished with the unit has a one-half inch pitch with

JULY, 1948

POWER GENERATION
53 W. Jackson Blvd.
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Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

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This boiler feed system, for example, shows how completely Crane fills your piping needs, regardless of the fluids to be handled. For Crane offers the world's most complete selection of brass, iron, steel and alloy piping materials. Standardizing on Crane gives you this 3-way advantage:

ONE SOURCE OF SUPPLY helps to simplify all piping installations—from design to erection to maintenance. Expedites purchasing and store-room procedures.

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OUTSTANDING QUALITY in every item from Crane assures uniform efficiency and dependability throughout any piping system.

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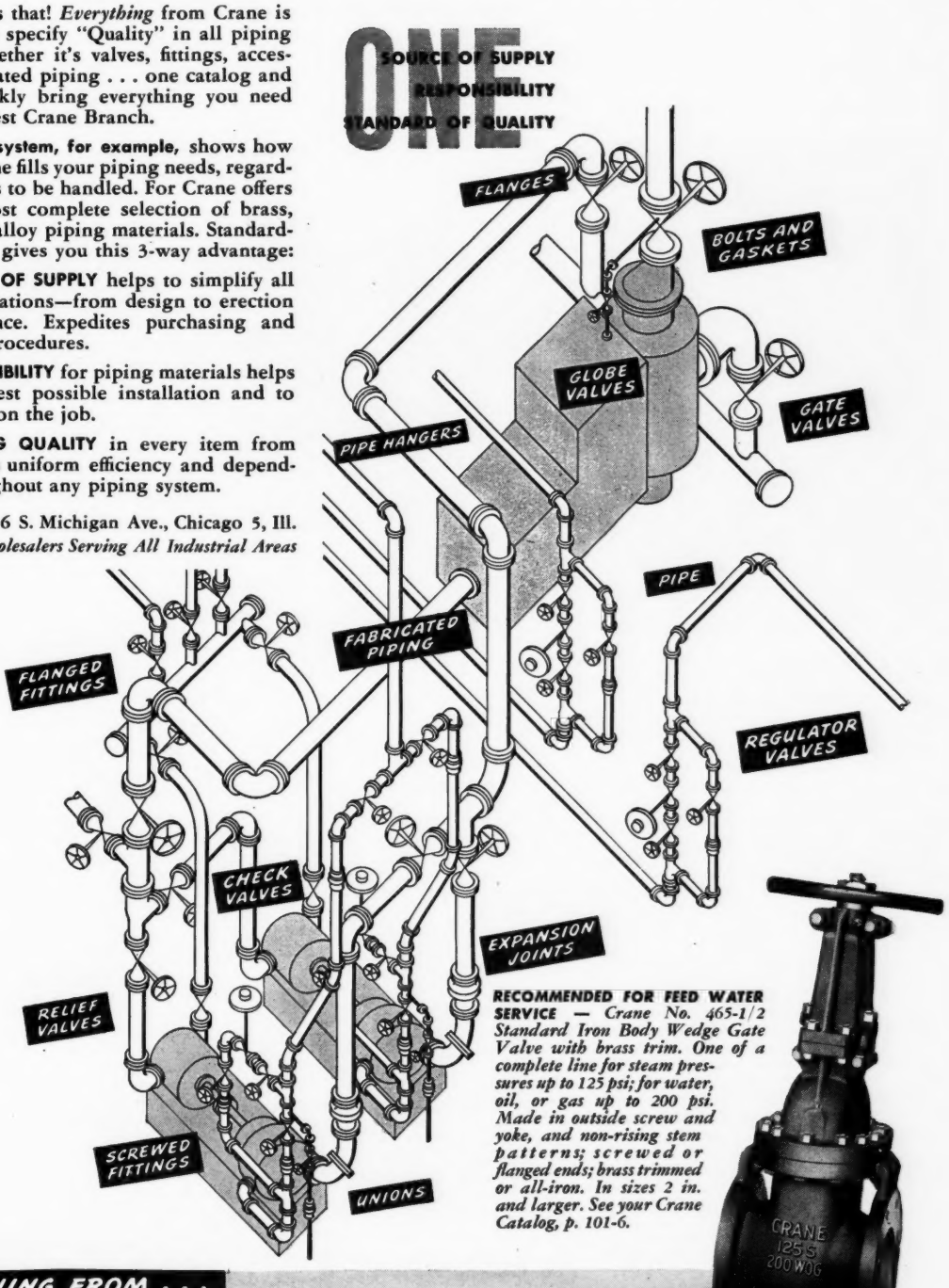


RECOMMENDED FOR FEED WATER SERVICE — *Crane No. 465-1/2 Standard Iron Body Wedge Gate Valve with brass trim. One of a complete line for steam pressures up to 125 psi; for water, oil, or gas up to 200 psi. Made in outside screw and yoke, and non-rising stem patterns; screwed or flanged ends; brass trimmed or all-iron. In sizes 2 in. and larger. See your Crane Catalog, p. 101-6.*

EVERYTHING FROM . . .

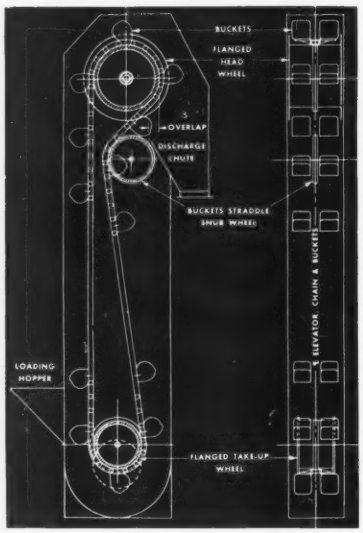
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

twelve teeth, suitable for use on standard number forty or forty-one chain. Crain-McCurdy Co.

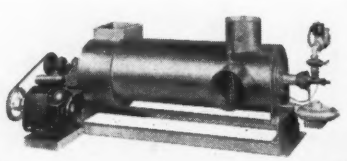
E Bucket Elevator. This elevator combines the advantages of other types and, at the same time, eliminates the difficulties usually associated with the handling of chemicals and some bulk materials. The use of a single strand of chain and a double row of buckets permits high capacities when operating at either slow or high speeds.



Even at slow speeds, the flanged pulley type head wheel and the discharge arrangement prevent spillage from the buckets when going over the head—all material loaded into the buckets is discharged into the chute at the end of the elevator.

The discharge and the flanged type head wheel of this single-strand, perfect discharge duplex bucket elevator permit the handling of hot, light, fluffy, fine, coarse, abrasive, fragile or sticky materials without maintaining any particular ratio between the bucket speed, the head wheel diameter, bucket size, and bucket spacing. Beaumont Birch Co.

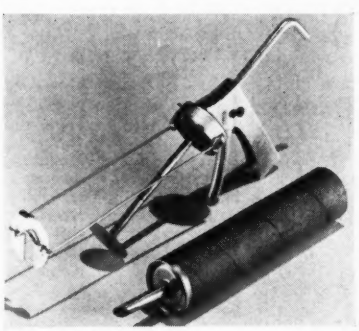
F Industrial Heater Unit. The Midget utility air heater with improved design features is now available as a complete package unit. In addition to the heater the package includes fan, motor, drive, safety devices and temperature controller. It is suitable for heating drying rooms and small industrial ovens. With a heating capacity of 125,000 Btu per hour, the heater is suitable for temperatures up to 350 F. The bricklined combustion chamber affords complete combustion of gas. The burner has good turn-down range, allowing proper temperature control. The fan capacity is 1000 cfm of air. Temperature controls of either the indicating or non-indicating type are furnished as desired. The safety devices are designed to shut off the gas supply in case of flame, power or fan failure. Gas Appliance Service, Inc.



G Hardness Testing Punch. In addition to its customary uses for indenting and marking hard metals and glass, the C-20 unit presents very important potentialities in the hardness testing of steels, particularly in the Rockwell C range of hardnesses. The method of use is to indent the material to be tested at an approximate punch pressure of 15-18 lbs., and the diameter

of impression is then compared visually (under 10 power glass) with the impressions made simultaneously on a series of standard Rockwell gauge blocks. It should not be difficult to position the unknown material between two standards and obtain an accuracy of plus or minus 3 points Rockwell C. Surface "bluing" will facilitate observation. Carboloy Co.

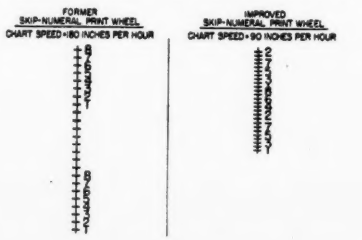
H Calking Gun. A new trigger type calking gun is announced that snaps over any spouted calking cartridge and requires no cleaning. No gun caps, nozzles, washers, bolts or tools to handle. Designed with a ratchet ram-rod connected to a round pressure plate and trigger handle that moves



pressure plate forward an eighth of an inch at every trigger pull. To operate, base of cartridge is dropped into metal recess formed as a part of handle. Front end of gun is then merely snapped down over neck of spout. The gun weighs less than 14 oz and is ideal for use in minor repairs around the plant. For sealing building cracks around window and door casements, and for glazing. Gibson-Homans Co.

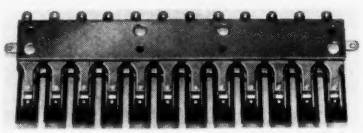
J Multi-Recording Print Wheel. An improved skip-numeral print wheel which when used with strip chart electronic recorders permits symmetrical and well-defined multiple measurement records has been developed.

Field tests show that the new skip-numeral print wheel overcomes a crossing of records and superposition of numerals of any one record. The new



skip-numeral wheel utilizes the same basic system of plus and numerical identification. It also staggers the numeral locations for different records permitting use of slower chart speeds. The use of slower chart speeds, is said to permit a substantial chart economy while maintaining greater clarity and permanency of recorded measurements, particularly when used in conjunction with standard charts made for electronic recorders. Brown Instrument Co.

K Gang Limit-Switch. The 12 gang open blade switch incorporates the patented rolling spring principle. Single unit, permanently fastened together with countersunk rivets for flush mounting at lower cost per switch and lower installation cost. Available with

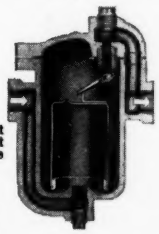


normally open, normally closed or double throw circuit on any pole or combination of poles. Reliability assured by maker's experience in originating and perfecting the rolling spring principle. Engineered for cam or plunger operation. Centerblade and rolling spring both of heat treated beryllium copper for long life. All other parts cadmium plated. Overall dimensions: 5⅞ by 2 1/16 by ½ in. Rated at 10 amp 125 v ac. Operating force 4½ to 6 oz. Maximum movement differential 1/16 in. Minimum overtravel 1/16 in. Minimum release force 2½ oz. Also available in other multiple arrangements. Acro Electric Co.

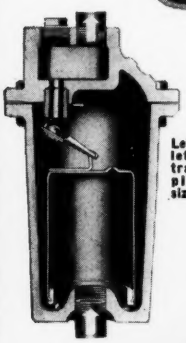
L Electrical Terminal Block. A terminal block which the manufacture claims will provide for many more connections in a given space, permit both rapid disconnection as well as positive locking of terminal leads has just been announced. Known as the Crablok, this new terminal strip is furnished in several lengths, and in either single or double-tier types as illustrated. The individual strips are simply placed end-to-end to provide any number of connections necessary. Because of the compact design, as well as the double-tier arrangement, space-savings over other types is claimed. In making normal quick-disconnect connections, the

WHY ARMSTRONG TRAP MECHANISMS *last so long!*

CHOICE OF BODY STYLES



Right: Side Inlet — Side Outlet traps for in-line installation.



Left: Bottom Inlet — Top Outlet traps in a complete range of sizes.

This Armstrong No. 213 trap on a storage type hot water heater has been in service 14 years without repairs.

WHAT USERS SAY

36 Armstrong Traps on heating system service in an Atlanta building still going strong without maintenance after 10 years.

* * *

One minor repair job in 20 years —that's the record of the Armstrong traps in service at South Dakota hospital.

* * *

Standardization on Armstrong traps slashed maintenance—first trap operating over 15 years without repairs—Canadian foundry.

SEND FOR the Armstrong Steam Trap Book—36 pages on trap selection, installation and maintenance. Free on request.

...They're built to stand 1500 psi, 1000°F

The user of standard Armstrong steam traps for medium and low pressure service reaps the benefit of the research, investment and experience that went into the development of Armstrong forged steel traps for high pressure generating station service.

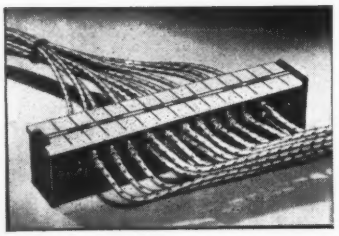
The valves and seats in all Armstrong traps are chrome steel, hardened, ground and lapped to a precision fit. The inverted buckets and valve lever assemblies are all corrosion resistant 18-8 stainless, heavily reinforced for wear. In normal service these mechanisms often last for years without attention. And when a valve finally wears to the point where it fails to seat properly, it is usually good for a relapping—a job any maintenance man can do in a few minutes. Or replacement is a simple, inexpensive job.

It's this built-in quality of Armstrong traps that keeps them on the job without leaking steam, without sticking or clogging, without frequent maintenance. Quality pays dividends when it comes to steam traps. Plan now to standardize on Armstrong, the *quality* traps. Call your Armstrong representative or write:

ARMSTRONG MACHINE WORKS

810 Maple St., Three Rivers, Michigan

ARMSTRONG STEAM TRAPS



contact tip is simply inserted into the spring-loaded socket connector which grips the tip firmly and provides a highly efficient electrical connection. Where desired, however, positive locking of the connection is quickly accomplished with a screw-driver. It is normally used in 220 v service, but can be safely used for higher voltage service up to 600 v by insulating the contact tips with plastic sleeves. Burndy Engineering Co.

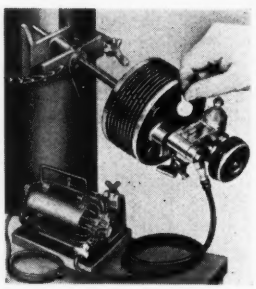
M **Draft Gage and Level.** A feature has been added to a style of transparent draft gages. The newcomer is a circular spirit level that has been built right into the body of its Visi-Draft. The Visi-Draft is small enough to fit into the hand, which means it can be used to level valves even in spaces usually considered too small to reach.

Both direction and amount of leveling necessary can be found in one fast check. The level is precision made and $\frac{5}{8}$ in. dia; it indicates 1 deg out of level with each 1/10 in, bubble movement. The instrument is made from a solid block of clear plastic. The scale is graduated in .01 in. divisions and easily read from above without danger of error. With the exception of the leveling bubbles no glass is used. Supplied in a durable carrying case, it is priced at $7.75. F. W. Dwyer Mfg., Co.

N **Tube Cleaning Cutter Head.** An improved swing-frame type cutter head for use in cleaning boiler tubes and for general service has been announced. The swing-frame type of cutter head consists essentially of a spider fitted with arms which swing out on arm pins under centrifugal force. The arms carry cutter pins on which

are mounted sharp, heat-treated cutters that do the work. In front are cone cutters for engaging thick accumulations, followed by star cutters for polishing the tube. No tools are necessary for disassembly of the head. All parts are of specially heat treated alloy steel. Lagonda Div., Elliott Co.

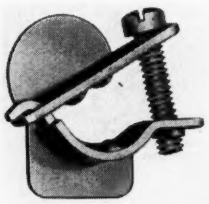
O **Oil Burner Smoke Test Meter.** A new portable meter for smoke tests on oil burners has just been introduced. According to the manufacturer, the meter consists of a sampling unit with a hose connection to an electrically operated vacuum pump



which may be set at any convenient place near the sampling point. For testing the smoke content of the flue gases of an oil burner, the sampling tube of the sampling unit is inserted into the flue pipe through a $\frac{7}{16}$ in. hole located between the furnace outlet and barometric draft regulator, and the sampling unit is then tightened against the flue pipe by means of a pipe saddle with chain and toggle clamp. A test disc is locked in the sampling unit, the electric cord of the vacuum pump is plugged into a standard 110 v a c or d c outlet, and its time control switch is thrown. Throwing the switch operates the pump, drawing an accurately-controlled sample of the flue gas through the test disc which turns the disc to a shade of gray varying from light to dark depending upon the smokiness of the flame.

The test disc is then removed, and the soot content of the gas sample is measured by registering the discoloration of the test disc with one of 10 shadings on a comparator scale which is supplied with the meter. The complete outfit, consisting of sampling unit, vacuum suction pump, comparator scale, and test discs are packed in a metal carrying case. Bacharach Industrial Instrument Co.

P **Cable Connector.** A simple, positive and economical method of connecting non-metallic sheathed cable to device and outlet boxes has been developed. Cataloged as No. 9049, the new product is formed of pressed steel, electro-galvanized, and is of the rock-in type. The outstanding feature of the new connector is the design and action of the hook that protrudes from the lower plate, up through a slot in the upper strap. When loomwire is inserted in the connector, the upper strap moves up and engages on the upper portion of the hook. This movement forces the integral flange, which is rocked-in through the knockout of the box to position itself off center. According to the maker, neither the top nor bottom integral flanges can be pulled through the knock-out without first removing the cable from the connector. This new connector has three small nodes on the inner gripping surfaces. These projections assure a tight hold on the cable without the danger of breaking through sheaths and insulations. Underwriters Laboratories, Inc.,

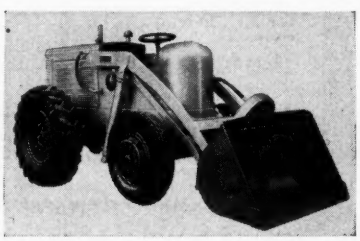


has approved the new connector for installation with loomwire or non-metallic sheated cable of sizes No. 14/2 and No. 14/3, and No. 12/2 and No. 12/3. National Electric Products Corp.

Q **Screw Conveyor.** This 9 in. screw conveyor was developed for bin to stoker direct feed. It is said to transfer coal at any angle from the horizontal to 60 deg. Designed to be either permanent or portable the screw is driven by a 2-5 hp motor depending upon the length. Lengths available are from 15 to 50 ft. Motor drives roller chain and enclosed worm gear drive at head shaft. Construction is of 13 ga

high tensile alloy steel said to be lighter, stronger and more resistant to abrasion than ordinary steel. Baughman Mfg. Co., Inc.

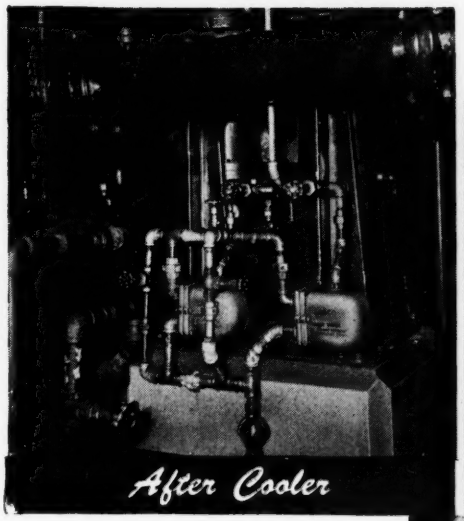
R **Improved Tractor Shovel.** Announced is an important improvement in the Model HF ¾ cu yd Payloader tractor shovel. Previously equipped with hydraulic lift and lowering of the bucket, the machine now has the added feature of hydraulic bucket

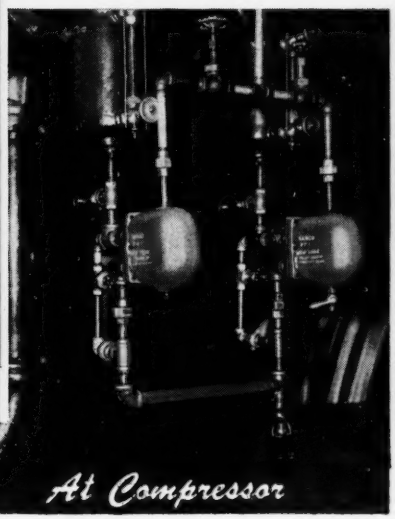


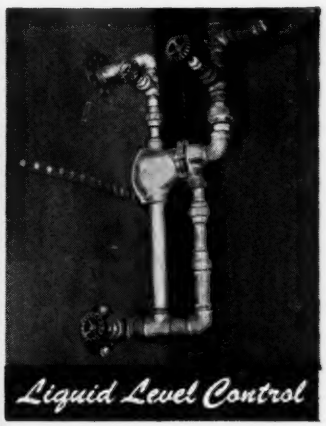
control which dumps and closes the bucket by fingertip actuated hydraulic power. Bucket can be dumped gradually or instantaneously as desired and can be closed immediately by the same hydraulic cylinder. Frank G. Hough Co.

Keeping Water Out

OF COMPRESSED AIR LINES


After Cooler


At Compressor


Liquid Level Control

Water vapor carried in compressed air is condensed when the temperature of the air changes. Water then collects in the bottom of receivers, tanks, or separators, as well as at low points in compressed air lines.

If such accumulations are not promptly removed, the passing air will pick up more moisture, which will condense at the end of the line in the tools or machines, where it may cause rusting, sticking, or spoiled work.

Sarco Float Traps, Type FA, are designed automatically to remove accumulated water from compressed air systems. The construction is similar to the well known Sarco "FT" steam traps used extensively in heating and process work.

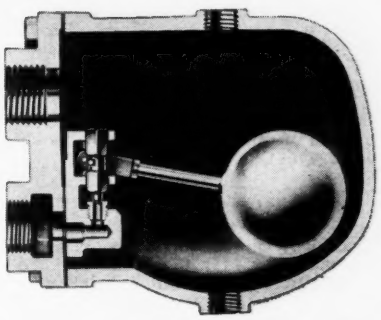
THREE PRESSURE RANGES: This type can be furnished suitable for the following pressures: Type FA-L, 0-75 lbs., FA-M, 75-150 lbs. and FA-H, 150 to 250 lbs.

LIQUID LEVEL CONTROL: Another adaptation of the FT trap is the Sarco liquid level control for use where float valve cannot be located inside the tank in which the liquid level is to be controlled.

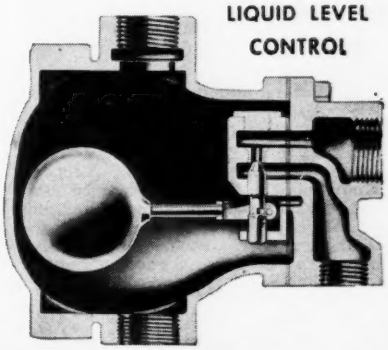
Two types are available; one for the better type house heating installations, where trouble-free operation and long life are considered along with first cost; and the second for industrial applications where liquid levels must be kept within narrow limits and where relatively small quantities of fluid are handled through the control.

191

COMPRESSED AIR TRAP



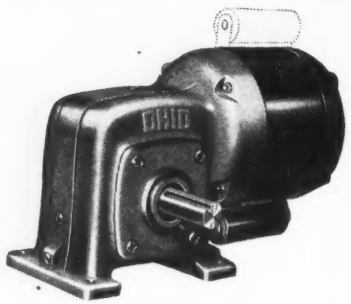
LIQUID LEVEL CONTROL



SARCO SAVES STEAM

SARCO COMPANY, INC.
Represented in Principal Cities
Empire State Building, New York 1, N. Y.
SARCO CANADA, LTD., TORONTO 5, ONTARIO

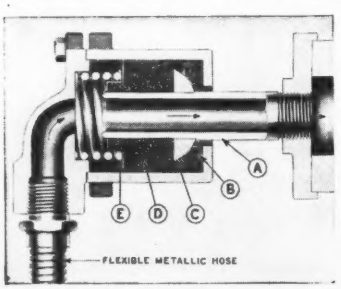
S Motorized Speed Reducer. A new line of motorized speed reducers in ¼ hp and ⅓ hp capacities is announced. These are designated as series M-1400 and M-1300. These units are engineered for long service. Ratios are from 5:1 to 72:1; output from 317 rpm to 24 rpm. Output torque from 43 in. lb to 354 in. lb. Housings are of special aluminum alloy. Worm gears are of special gear bronze, selected for greatest strength with a minimum coefficient of friction. Worm and motor shaft are integral, made of hardened steel and ball bearing mounted. Output shaft is extra



heavy with ample bearing support. Output shaft roller bearings are mounted in cast iron covers and input shaft bearing is mounted in cast iron carrier cap. Two types of general purpose motors are available; capacitor type in 115 v and 230 v, also three phase type in 220/440 v. They are precision built, of drip-proof construction. Cast-in-terminal box permits easy wiring. Heavy duty ball bearings throughout. A special feature is the new Torq Syncrosnap starting switch which insures precise snap-action, and eliminates damage through burned-out windings. Capacitor may be mounted above or below motor as shown. Ohio Gear Co.

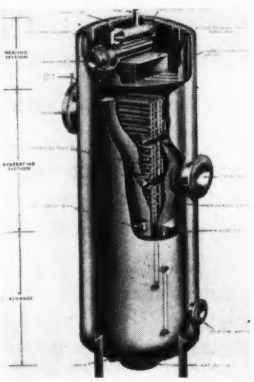
T Sanitary Fatigue Mats. These mats are made in brown or black, sizes 31 by 46 in., 30 by 35 in., 16 by 23 in., and 16 by 46 in. The mats are said to have ribs that permit circulation of air under the feet yet the ribs are stiff enough to carry a man's weight with just enough resilience to relieve fatigue from long standing. Mid-West Development Co.

U Rotary Pressure Joint. A new development has been announced; a pressure joint, one which has been designed to be self-supporting and require no external piping support. Known as the Type-S, it will be used like the standard joint to admit heating or cooling agents to rotating rolls, particularly where considerable lateral movement of rolls is encountered, or



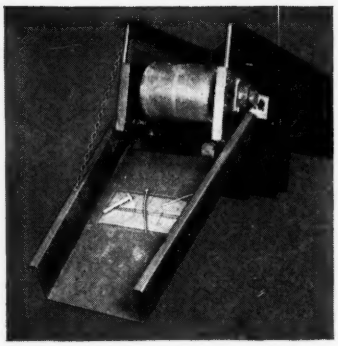
where supports for the standard Joint can not be satisfactorily provided. It will find application in paper and textile mills, and in a wide variety of other processing plants. The new Type-S is completely self-lubricating, has no packing of any sort, and adjusts itself automatically for varying pressures. It has a spherical sealing surface which maintains an effective seal even though wear should occur at this point. In this new joint a large bearing or guide of carbon graphite supports the entire weight of the joint. It is accurately fitted inside the body, where it provides a bearing surface on the rotating nipple. The seal proper is effected between a hemispherical collar on the nipple and another carbon graphite bearing ring. Pressure itself is the sealing force—the higher the pressure the tighter the seal. Four sizes are available, ½, ¾, 1, and 1¼ in. all suitable for 150 lb pressure, temperatures to 400 F. Johnson Corp.

V New Feedwater Heater. The elimination of the customary vent condenser from a deaerating feedwater heater has been accomplished. An inlet spray assembly and a vent collecting hood do the work of the many small tubes and other parts comprising the vent condenser formerly used. Inspection of the inlet spray assembly may be made by withdrawing the assembly from the inlet nozzle. All parts in the



heating section, except the non-ferrous inlet spray assembly, are of stainless steel. Trays, inlet spray assembly and access opening cover are the only removable parts in the entire unit, other parts being permanently welded to the shell since they require no maintenance or adjustment. The fabricated stainless steel trays are inspected or removed through the access opening. Performance guarantees on the deaerating heater are 0.005 milliliter per liter oxygen on the multiple tray compartment type and 0.03 ml/1 on the single tray compartment type. Elliott Co.

W Magnetic Trap Conveyor Chute. Announced now are lightweight conveyors which are available with adjustable chute that removes all stray iron from the bulk material being conveyed. The chute, which may be attached or detached as desired, has a powerful, permanent magnet built right into it. It traps nuts, bolts, nails, or wire, which may be in the conveyed material and thus protects valuable machinery from breakdowns, helps eliminate product contamination and reduces the danger of fire and explosion caused by friction sparks from tramp iron. May



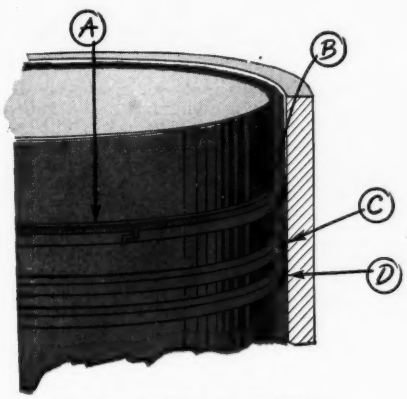
be used with any non-metallic material such as chemicals, grains, foods, coal, fertilizers, etc. Magnet is made of high-grade Alnico. Maximum recommended speed for efficient operation of magnet is approximately 100 fpm. Material Movement Industries, Inc.

X Valve Capacity Calculator. A valve capacity calculator applicable to the new Kontrol-Motor diaphragm valves and pressure regulators, is available. The calculator was developed from the results of extensive laboratory tests and is based on three factors: (a) Rate of flow through the valve, or capacity; (b) Static pressure and pressure drop through the valve, or resistance; (c) Valve size. Correction scales for steam quality and liquid and gas specific gravity are included as well as a flowing temperature scale for gases. Of circular slide-rule type, the calculator, 8 in. dia, has long, open scales that are easily read. Kieley and Mueller, Inc.

Y Condensate Return System. A new condensate return system for steam heating boilers and steam generators is announced. The unit is complete on a steel base with an 18 or 30 gal tank receiver, automatic float switch and a bronze-fitted turbine pump and bronze-fitted check valve and strainer. The ¼, ⅓, ½ or ¾ hp motor is equipped with an automatic overload cut-out switch.

As steam condensate fills the tank, a float switch starts the turbine pump, returning the hot condensate to the boiler. When the tank is nearly empty, the switch opens and stops the pump. Operation is completely automatic. The feature of the system is the pump, which is a nonpulsating turbine type. It is self-priming. Does not vapor lock or steam bind. Maximum condensate

CASE D119A--MAINTAINING FULL POWER IN DIESEL ENGINES.



SECTION OF DIESEL ENGINE PISTON

Operators of Diesels in all types of service report RPM DELO Diesel Engine Lubricating Oil materially reduces power loss in three ways:

A. Detergent compounds prevent ring-sticking, allow full ring tension against cylinder wall, and this minimizes compression loss.

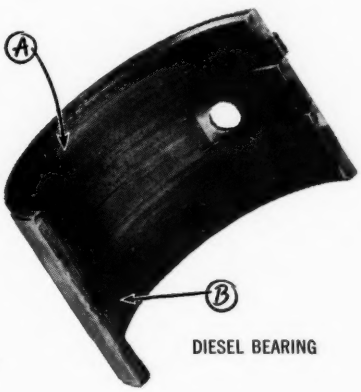
B. Metal-adhesion additive keeps full oil film on hot upper cylinder walls. These danger areas are often left unprotected by many oils.

C. RPM DELO Oil maintains a tough oil seal that stops blow-by of combustion gases.

D. An anti-oxidant increases the inherent stability of RPM DELO Oil's selected base stocks and resists lacquer formations on liners and piston skirts.

Other additives in this pioneer compounded oil prevent foaming, and control gum formations.

CASE D119B--PREVENTING FREQUENT BEARING REPLACEMENT DUE TO CORROSION.



DIESEL BEARING

In normal operation, Diesel engines require excess oxygen and operate at high temperatures. Under these conditions many unstable lubricants tend to turn corrosive and attack the lead in the copper-lead structure of alloy bearings. RPM DELO Diesel Engine Lubricating Oil is especially compounded to prevent this cause of bearing failure.

A. Selected base stocks are used that are naturally resistant to oxidation, the cause of most bearing corrosion.

B. Anti-oxidation compounds in RPM DELO Oil further reduce the danger of corrosion.

In laboratory corrosion tests, copper-lead bearing strips immersed in RPM DELO Diesel Engine Lubricating Oil showed considerably less weight loss than those protected by similar type oils.

For additional information and the name of your nearest Distributor, write

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RPM CALOL

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temperature is 180 F. There is no strain on the motor because the full load is applied only after the motor attains its top speed of 1750 rpm, according to the manufacturer.

Capacities from 2,000 to 12,000 sq ft of radiation, E.D.R. with pump ratings of from 3 to 18 gpm are provided, based on a condensate temperature of 180 F. Wayne Home Equipment Co.

Z **Terminal Connector Tool.** For maintenance, repair, and limited production work, there is available a heavy duty hand tool for installing this firm's terminals on solid or stranded wire in sizes 12 to 4 inclusive. Trademarked AMPli-Crimp, this tool features

interchangeable crimping inserts, compound leverage and full toggle action, and has heat treated jaws for long wear and extra strength. The average male operator is enabled to exert sufficient pressure with this tool to attach terminals in sizes heretofor applied only by power press. Aircraft-Marine Products, Inc.

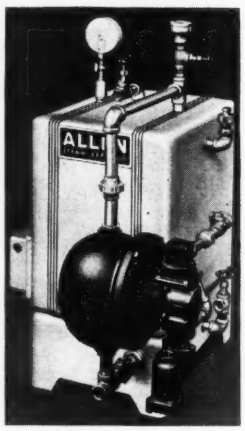
AA **Improved Waterproofing.** Announced is the improvement of the No. V transparent waterproofing formula. A waterproofing for outside walls, brick, stone, stucco and kindred surfaces. The improvement consists of incorporating calcium and aluminum sterates, the jells which have been broken down chemically, together with 60 per cent paraffin and 40 per cent chloride, which adds to the insolubility of the matter in water and rains. Available in cases of 1 gal cans at 4.50 per gal and 1 gal Steel Kits at $4.40 per gal. Ranetite Mfg., Co.

BB **Fuel Oil Additive.** A new fuel oil additive eliminates sludge in fuel oil storage tanks by reducing fuel oil viscosity, breaking up emulsions and separating excessive amounts of water from the oil. It eventually cleans out the entire system from storage tank to burner. Flame is said to be cleaner, brighter and larger with more complete combustion. Brooks-Ol is added to the fuel tank just before each new oil delivery. One gallon treats approximately 2,000 gal of fuel oil. The company is offering a sample test kit consisting of a small bottle of the product, a dropper and a "watch glass" dish. With this kit, engineer can test the action of the product against sludge from his own fuel oil tank. Brooks Boiler Treatment Co.

CC **Panel Instruments.** A new line of 3½ in. panel instruments of internal-pivot design, suitable for use in radio, power supplies, transmitters, amplifiers, and aircraft, has been announced. The instruments, designated as Type DO-71, have been especially designed for better readability. The elimination of arc lines and distracting printing from the scale and the use of a lance-type pointer and large, clear numerals assure accurate readings. The internal-pivot construction of the new instruments materially reduces their depth behind the panel, thereby increasing their suitability for radio, communications, and other apparatus in which compactness is essential. A high-strength Alnico magnet provides high torque which makes for quick response and good damping so that the moving system follows changes in current or voltage rapidly and accurately. The high torque allows the use of larger-radius pivots, resulting in increased resistance to shock and vibration.

The large clearance in the air gap between the pole faces and core minimizes the possibility of the stickiness that normally results from collection of dirt and foreign particles in the air gap under adverse conditions. General Electric Co.

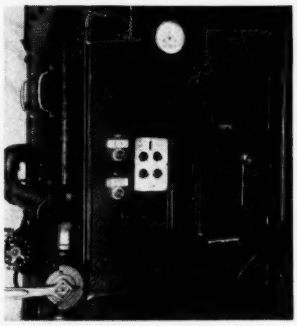
DD **Electric Steam Generator.** A compact unit that can be placed convenient to equipment and connected directly to it. Constructed of steel, welded to withstand a hydrostatic test of over 500 psi, it is enclosed in a cast aluminum housing with rockwool insulation. Immersion heating units are copper clad. Protection is with automatic float type water feed, low water electric cutoff and pressure switch. Current required is either 220 v or 440 v,



single or 3 phase, 50 or 60 cycle, a c or d c. Current cuts off at working pressure and automatically resumes on pressure drop of 2 lb. Water pressure must be 5 to 10 lb greater than working steam pressure. Available in 9, 12, 15, 18, 24, and 30 kw sizes to supply steam up to 100 lb pressure. H. P. Cooper & Co.

EE **Dual Fuel Diesel.** An advance toward simplicity of operating dual-fuel diesel engines has resulted from the development of automatic electric controlled accessories operated by two push buttons. With the new type of control these engines give no indication of fuel changes while operating under full or partial loads except by indicator lights above the two change buttons or, if desired, an alarm signal.

Fundamentally the dual-fuel engine substitutes a portion of gaseous fuel mixed with combustion air for a corresponding portion of liquid fuel. The engine continues to operate on the diesel cycle with compression ignition. When the Superior dual-fuel engine operates as a full diesel, with fuel oil alone as fuel, there is no functional difference between it and other

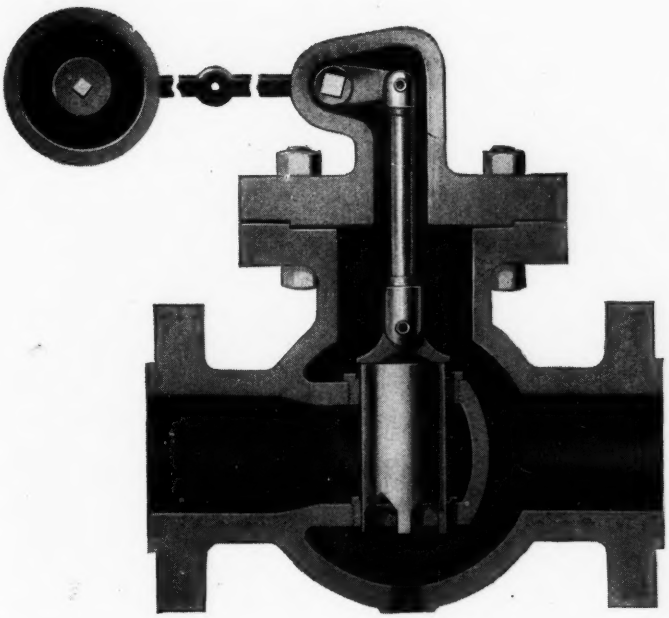


diesels not equipped for dual-fuel—that is, the fuel oil is ignited by the heat of compression. With gas as the fuel, however, ignition by the heat of compression alone is not dependable and therefore a small quantity of fuel oil is injected into the combustion chamber. This oil ignites readily and in turn ignites the gas-air mixture in the cylinder. Engines are started and stopped in the same manner as a conventional diesel by means of a Stop-Run lever and a separate Air Starting Pull Handle. After the engine is started, operation is automatically regulated by the governor and the special controls. The push button control panel, which is mounted on the governor housing, is used only when the engine is running. One button is marked OIL and has an amber indicator light. The other button is marked GAS and has a white indicator light. These push button controls are connected with an automatic alarm and safety system, and through electric relays operate a solenoid valve in the gas line.

If it is desired to operate the engine on less than full load gas requirements, the hand operated valve in the gas supply line may be set on its graduated dial to restrict the flow of gas to the desired amount. The governor then increases oil fuel injection automatically to the required amount. To change back from dual-fuel operation to oil operation, it is only necessary to press the "OIL" push botton. The engine may be stopped simply by moving the standard control lever to "STOP" position. National Supply Co.

FF **Electric Etcher.** Anything made of steel, iron or their alloys, can be marked with a new electric etcher. The unit is enclosed in a streamlined, metal case for ready portability from one job to another. When opened, the cover forms a work plate on which to place small tools and parts for etching. A ground clamp is furnished for use when etching parts that are too large for the work plate. The etching tool does not get hot because the point is so mounted in the handle that cooling air can circulate around it. Four etching heats, 120, 240, 420 and 700, make this etcher suitable for marking permanent identification on tools and instruments, names on products, marking stock, part numbers and sizes, model, voltage or other information regarding use. Ideal Industries, Inc.

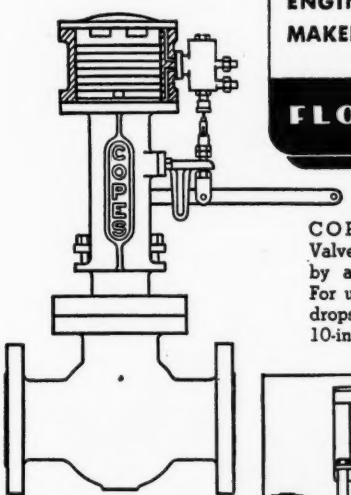
COPES BALANCED VALVES



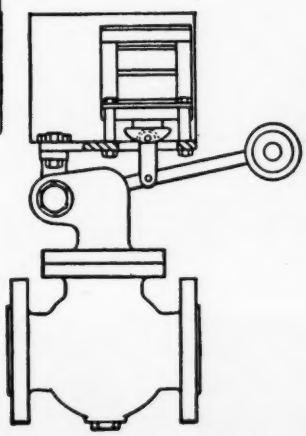
A valve may be statically balanced while at rest, yet be so badly unbalanced dynamically—when handling flows under pressure—that inaccurate response to the actuating element causes a "hunting" action which makes impossible the desired precision of control. In COPES Valves, unbalanced forces are held within narrow limits over the entire operating range. This is why so many have been purchased *at a premium,* where control must be precise with actuation by float, solenoid or other element. Sizes: ¾-inch and up. When writing for data, give complete information on your operating needs.

ENGINEERED BY THE MAKERS OF COPES

FLOWMATIC



COPES Type SLH Valve, relay operated by air, oil or water. For unlimited pressure drops. Sizes: 1½- to 10-inch.



COPES Solenoid Valve has direct or tripper action. For pressure standards to 300-psi. Sizes: ¾- to 6-inch.

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Because they eliminate the commonest source of trouble and expense in ordinary blow-off valve service, Yarway *Seatless* Blow-Off Valves mean real economy to boiler plant operators. *Yarways have no seat to score, wear, clog and leak.* Lubrication is usually the only maintenance they require.

Yarway introduced the seatless principle with the balanced sliding plunger many years ago . . . has constantly improved and adapted it to meet modern service requirements. Mechanical and metallurgical research in Yarway's own Steam Laboratory anticipates changing conditions . . . keeps Yarway valve design ahead.

There is a Yarway Blow-Off Valve for every pressure.

SEND FOR FREE BLOW-OFF VALVE BOOKLET. PLEASE INDICATE THE PRESSURE OF YOUR BOILERS.

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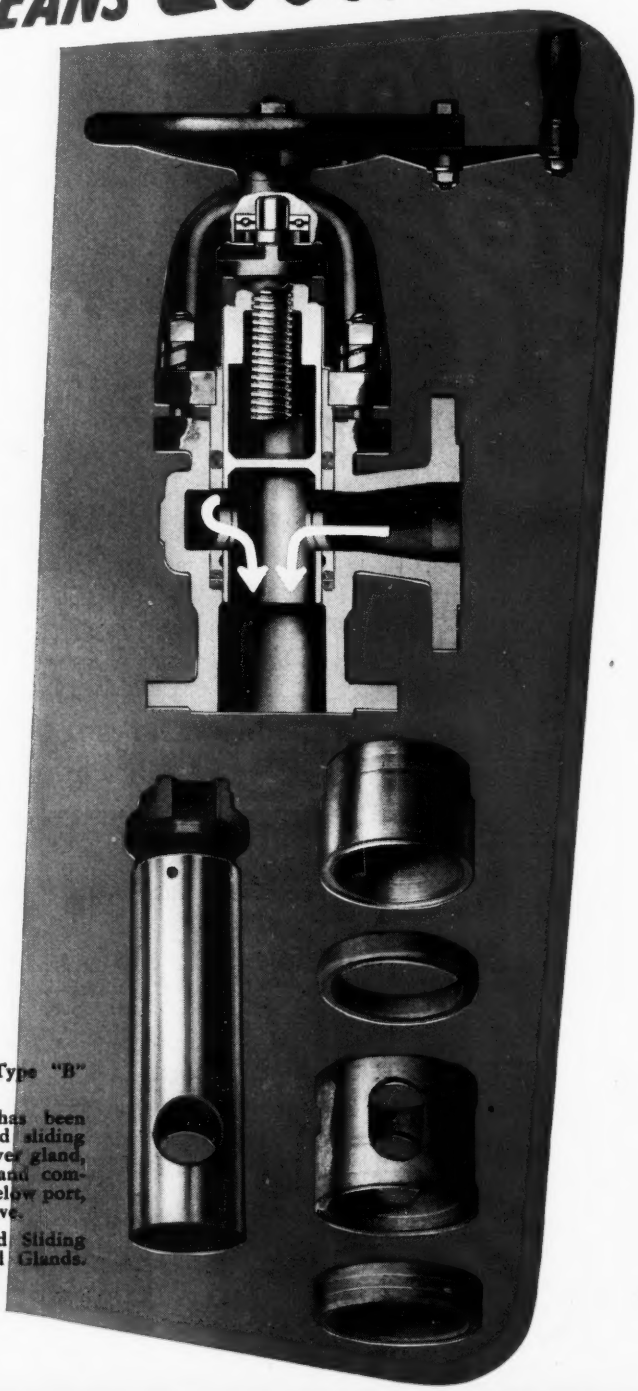

(*Above*)—Cross section of Type "B" Seatless Angle Valve, flanged.

OPERATION: After valve has been closed, shoulder on balanced sliding plunger contacts upper follower gland, forcing it down into body and compressing packing above and below port, making an absolutely tight valve.

(*Below*)—Type "B" Balanced Sliding Plunger, Packing Rings and Glands.

Forty Years 1908 YARWAY 1948

YARWAY BLOW-OFF VALVES

WHAT LEADERS SAY

More Science In Security Planning

By WALTER EVANS

OUR NATION shows a persistent record of hind-sightedness in applying its tremendous civilian research know-how to military matters. We must modernize our thinking about military procurement to include scientific brains—along with bullets, and beans, and brawn, and the other measurables, if we are to live in peace in this atomic age.

We must make a realistic appraisal of the dangers, and common sense planning now, to minimize the possibilities of armed aggression.

To do this, we must propose sweeping changes in national preparedness thinking, under which science and industry would be admitted to full membership, along with the military, in top-level planning councils. It might be suggested that American security be entrusted to a great, integrated, combat team of four triple-threat departments, as follows:

1. A military high command to map plans and list requirements in the light of existing tools of defense.
2. A nationwide research organization to maintain a never-ending vigil in the laboratories, seeking out new devices and techniques.
3. An industrial militia to convert the scientists' models to production-line equipments, and to establish manufacturing procedures for passing along to subcontractors in times of emergency.
4. An Army, Navy, and Air Force adequate to test equipment in the field and to train efficient operating and maintenance personnel.

There is a great need for such over-all planning. Even under the growing pressures of World War II, research brains had not qualified as a bona fide item of military procurement—because traditional procurement had centered around those items which could be counted, or weighed, or photographed for the benefit of Congressional Committees.

Funds for the Office of Scientific Research and Development, which handled early projects, came not from readily identifiable appropriations but through the devious device of a special executive appropriation in which the purchase of brain power would not stand out too prominently.

We must address the budget-makers in Congress and the American people—not the admirals and generals who must live within assigned budgets—in terms like this: "Continuing long-term research for preparedness will cost money—a great deal of money. It will require implicit faith in our scientists and in industry. Every idea explored will not produce a worthwhile development. We must be prepared to gamble to this extent."

We must end the old order of thinking under which military men felt duty-bound to "have something to show Congress" for every research dollar expended. Some research just doesn't produce immediately showable results. Some projects may be complete duds. We must face this possibility. To do otherwise will be to revert to the kind of thinking which strangled military research in private industry between wars.

Contracts for research must allow privately owned interests, whether in industry or in the colleges and universities, a reasonable profit. This is self-evident, because we are endowed with a limited amount of top-flight research talent, and our competitive economy demands that this talent be employed to earn a reasonable return. Non-profit contracts just don't attract the best brains.

Above all, we must recognize that this is an all-or-nothing venture. If we espouse such a long-term program of continuing research it must be an all-out effort . . . no half-measures . . . no short-sighted economics. Prudent supervision and control of expenditures, by all means—but no penny-pinching. Let's bear in mind that as dollars invested in research planning go up, the need for wartime expenditures in lives and dollars goes down.

Scientists bear their responsibility in educating the nation to more alert scientific preparedness thinking. Congress will not vote funds sufficient for this broad research effort without clear indications from the grass roots that such a program is wanted—that American fathers and mothers see in it the hope of staving off future wars . . . of creating a real world at peace in which to raise their families.

Walter Evans is vice president of Westinghouse Electric Corp. and vice president and general manager of Westinghouse Radio Stations, Inc. The above is a condensation of a paper he delivered last November before the National Electronics Conference. In the light of national developments since that time, Mr. Evans' comments seem even more pointed today than when they were originally delivered. For already many of the conflicts in, and obstacles to, the proper integration of science into security planning have made their appearance.

True, the overall planning is taking the general direction advocated by Mr. Evans and many others. For example, the paper by Walker L. Cisler, (May issue, page 53) outlining a program for integrating our power industry into security planning has received the most careful study. Already an organization has been set up for an Office of War Utilities, to be headed by Edward Falck, its former chief of World War II, and to include Mr. Cisler and many other top power utility men. Some of the procedures advocated above by Mr. Evans have at least been talked about at very high levels.

But are the Congress and the American people yet aware of all the implications of these proposals and are they prepared to pay the cost of them, not alone in money but in effort? It is because of our doubts on this point that we present again these cogent comments by Mr. Evans, calling on the American people to understand how vital science will be in the security program they obviously want.

Mr. Evans was born in Columbus, Ohio in 1898, studied electrical engineering at the University of Illinois, served in the Navy in World War I, returned to the University of Illinois and later attended the University of Chicago. Interested in radio from boyhood, like so many of his generation, Mr. Evans became a ship's radio operator on the Great Lakes at 17, was an instructor and 1st class operator in World War I, then worked as ship's operator for Marconi Co., RCA, United Fruit Co. and others.

He joined Westinghouse in 1921 as a radio operator at the then new Station KYW in Chicago and has been prominently identified with all company radio activities since that time. He rose rapidly through ranks of station chief engineer and technical superintendent for all stations; and in 1933 was made manager of the Radio Division in charge of all manufacturing as well as broadcasting. He has been a vice-president of the subsidiary since 1939 and of the parent company since 1942. He is a member of IRE, Army Ordnance Association, ASNE, and other technical and social organizations.

REDONDO STEAM STATION Brings

Although not designed for extreme efficiency because of a relatively low load factor, the new Redondo Steam Station of the Southern California Edison Co. is without question one of the most up-to-date stations in the world. Among the unusual features which had to be met were the necessity for instantaneous load pick-up, capability of withstanding earthquake shock, and the periodic reversing of the condenser circulating water flow. The initial installation of two 60,000 kw turbine generators and four boilers went into operation in February of this year

By W. C. WOODMAN
Mechanical Engineer, Stone & Webster Engineering Corp.

THE REDONDO STEAM STATION went into service on February 23, 1948. Placing this station in service will materially reinforce the electric power system owned and operated by the Southern California Edison Co. and will keep pace with the rapidly growing demand for power in Southern and Central California. The design and construction of this plant has been undertaken by Stone & Webster Engineering Corp. working in close collaboration with the engineering staff of the Southern California Edison Co.

Operating conditions may require this plant to serve as a base load station during dry seasons when the capabilities of the hydroelectric plants in the system are insufficient to meet the load demand. At other times the Redondo Steam Station will operate as spinning reserve ready to pick up full load instantaneously in event of outage of the electric tie lines which supply hydroelectric power to the area in which the steam station is located.

The steam station has been placed on the waterfront of the city of Redondo Beach and occupies the same site as that of an older station bearing a similar name which has recently been dismantled. The initial installation consists of two 60,000 kw turbine generators and four boilers, while a recently authorized extension will double the present generating capacity.

Speed in design and construction has been a paramount consideration, and for this reason AIEE-ASME Preferred Standard turbine generators, and boilers which closely followed an existing design, were se-

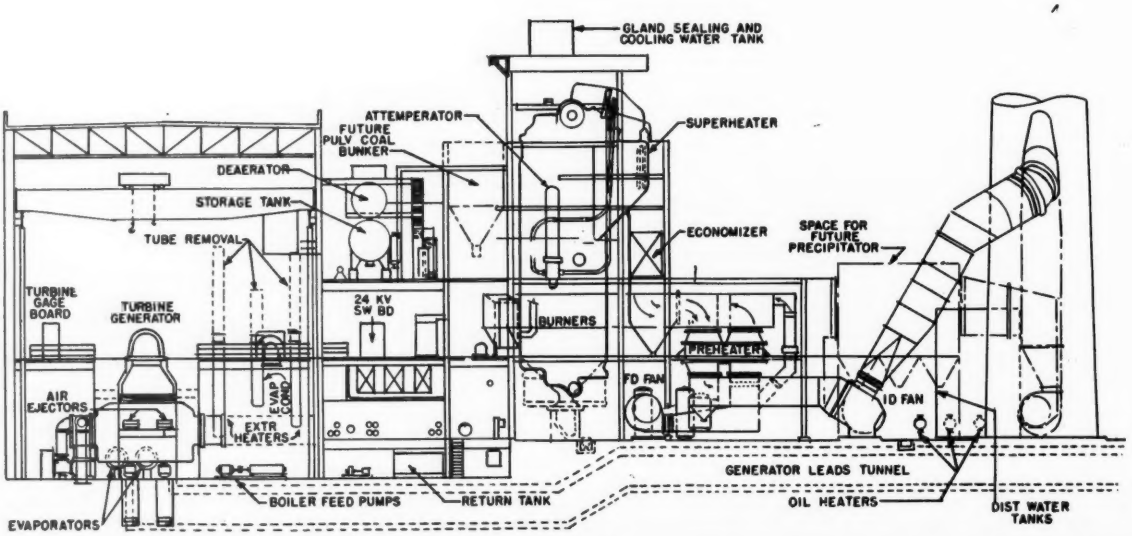

Fig. 1. Sectional layout of plant. Outdoor boilers with covered firing aisle combine economy of construction with operating convenience

Needed Power to Southern California

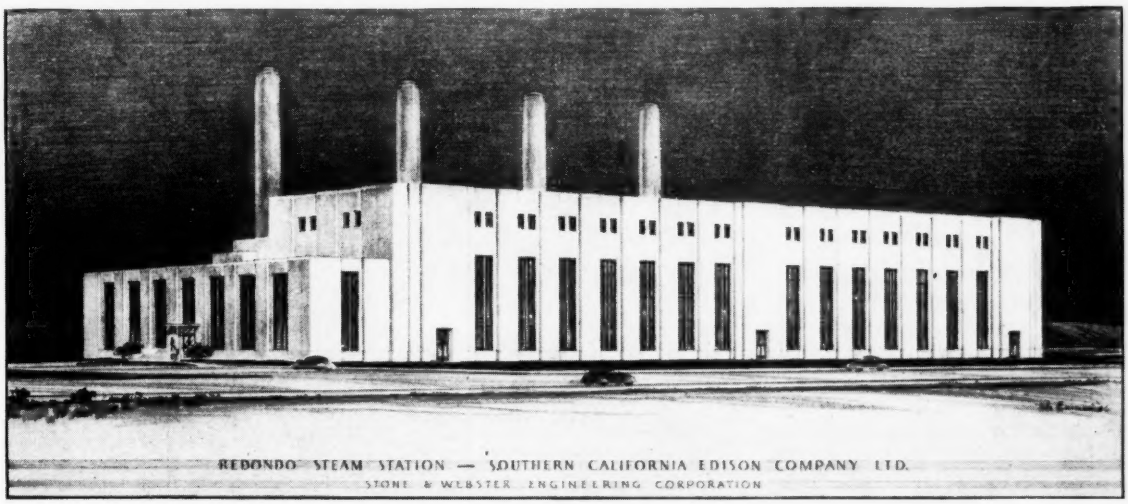

Fig. 2. Architects drawing of Redondo Station

lected. It was not economical to design for extreme efficiency because of a relatively low load factor resulting from the relaying of hydroelectric power. Instead, a standard regenerative cycle, employing four of the five feed-water heaters permitted in the Preferred Standard design, was selected. Although speed and simplicity have been governing factors throughout this project, it is not intended to imply that the design has not been exacting. A number of unusual features required special study and development, among which were, (1) the necessity of designing for almost instantaneous load pickup, (2) the building of a steam station in a country occasionally subject to earthquake shock and, (3) because of the special conditions surrounding the design of the condenser circulating water tunnels at this station, the necessity of periodically reversing the flow in these tunnels.

The architectural features of the station are illustrated in Fig. 2. Since the station is located on a traveled waterfront highway and not far from the residential sections of the city of Redondo Beach, the most modern architectural features have been employed.

A semioutdoor installation is one feature of the design. Turbine hall and the condenser and pump room are housed. The boilers are of the outdoor type, but the firing aisle is enclosed, thus combining economy of construction with operating comfort and convenience. Fig. 1 shows a sectional layout of the plant.

When operating full load and allowing for 1 per cent evaporated make-up, the heat rate of the turbine cycle shown in Fig. 3 is 9530 Btu per kwhr.

Condensate is pumped from the condenser hot well by one of two duplicate vertical motor-driven pumps and circulates as a cooling medium through the steam jet air ejector condenser, the hydrogen coolers and the turbine oil cooler and is delivered to the suction of one of the two duplicate motor-driven horizontal condensate booster pumps. The booster pump returns the condensate through the fourth and third point feedwater heaters and the evaporator condenser to the second point deaerating feedwater heater. At some seasons of the year, the temperature of the condensate will exceed 90 F, the maximum allowed in the hydrogen coolers, and under these conditions, condensate will first pass through a precooler using sea water obtained from the main circulating water system. In order to maintain the constant flow of 600 gpm of condensate required by the hydrogen and oil coolers, with condenser flows varying from 75 to 1000 gpm, a condensate recirculation control system has been designed. A flow indicator-controller, installed in the cooler circuit actuates, by dividing its control range between them, both a by-pass control valve around the coolers and a recirculation control valve to the condenser, in order to maintain a normally constant flow of 600 gpm through the coolers under a varying flow to the condenser. The recirculation control valve opens when the cooler circuit flow tends to become less than 600 gpm, while the cooler by-pass control valve opens when the flow through the coolers tends to exceed 600 gpm Controlled make-up of any deficiency in the quantity of condensate in the system corresponding to low hot well level in the condenser is obtained from distilled water storage tanks, while any excess of condensate in the system corresponding to high hot well level is discharged by the condensate booster pump through the high level control valve to these distilled water tanks. Features of the condensate and feed water flow control system are illustrated in the Fundamental Flow Diagram Fig. 4.

Feedwater heaters for the first, third and fourth steam extraction points are of the closed type. The second point feedwater heater is of the open deaerating type and supplies the suction of the boiler feed pumps. Provision is made for maintaining minimum steam pressures in the first and second point feedwater heaters. This assures both such minimum feedwater temperature entering the boiler economizer as will keep the air preheater flue gas temperature sufficiently high to minimize corrosion, and also provides effective deaeration in the second point heater. Pressure reducing valves from the station 200 psi steam system maintain minimum pressures of 55 and 10 psig at these two points.

Three motor-driven, constant speed boiler feed pumps are pro-

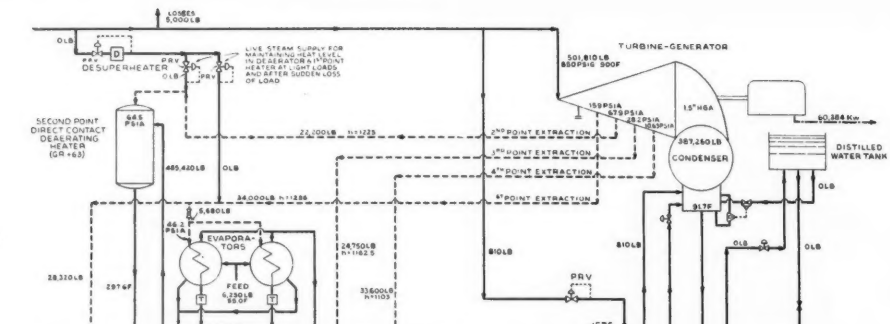

Fig. 3. Heat balance diagram. Full load, 1 per cent make-up.

vided for each unit, with one common turbine driven feed pump. The boiler feedwater level control is of the three-element type in order to provide flexibility of control and rapid response under the demands for quick load pickup.

The evaporator feedwater make-up system has a capacity equal to 3 per cent of the normal full load steam for each unit. Steam is supplied from the first extraction point, and the evaporated vapor passes to an evaporator condenser located in the condensate return system between the second and third bleed points. A small zeolite water treatment plant provides the evaporators with feed water free of scale-forming elements.

For simplicity, extraction heater condensate is cascaded to the fourth point heater from which duplicate vertical motor-driven pumps return it to the main condensate system.

The station building has a steel frame with walls of reinforced concrete and with an exterior finish of architectural concrete. Interior finish is also concrete with red granolithic floors in the turbine room.

The entire structure is designed with a seismic co-efficient of 0.2 G because of the possibility of earthquake disturbance. Since the location is on a sandy beach adjacent to the Pacific Ocean where there are compressible strata immediately underlying the surface sand, it has been necessary to carry the loads through cast-in-place concrete piles into the firm sand below. About 2300 piles were required for the first section. These are 30 to 40 ft long and develop a friction bearing of about 35 tons each. Pile caps, including the turbine generator foundation mats, are rigidly interconnected by a series of heavily reinforced concrete struts.

The entire structural frame is riveted, except for certain seismic connection employing welded construction. The superstructure is heavily braced both longitudinally and transversely to resist stresses from possible earthquakes. Longitudinally the principal bracing is the reinforced concrete exterior walls and a system of diagonal members located in the steel framing. Transversely, seismic loads are transmitted through a system of diagonal bracing in the steel frame.

The station faces a traveled waterfront highway with the boilers and the stacks to the rear. The first section of the station building is approximately 300 ft. long, with the ultimate building to be about 540 ft in length. The width of the building proper, including the turbine hall and an auxiliary bay is approximately 120 ft.

Two stacks are provided in the first section, one for each pair of boilers. Stacks are 200 ft high with an inside diameter of 14 ft at the top, and are self-supporting on their own pile foundations. Stacks are of reinforced concrete construction

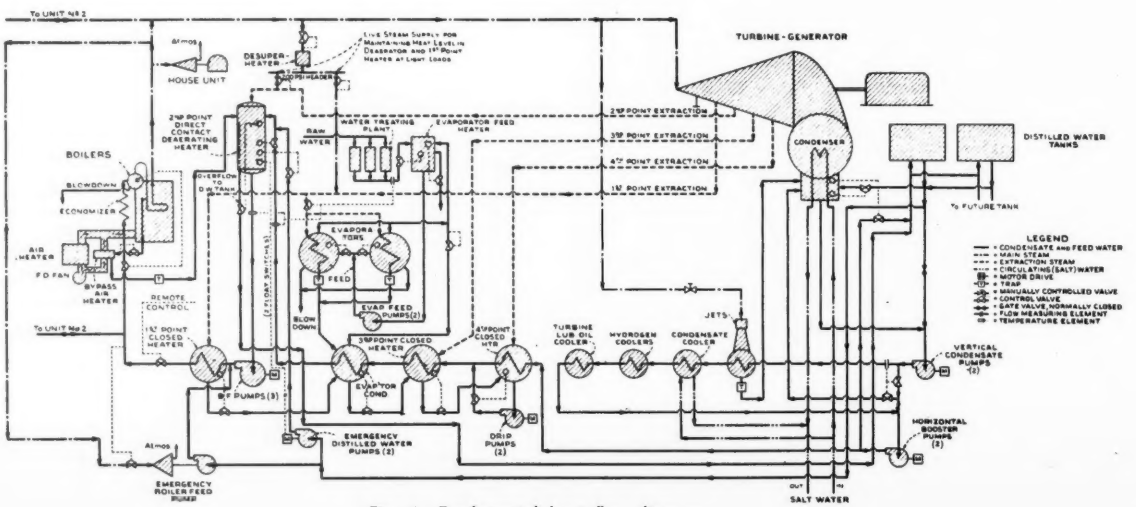

Fig. 4. Fundamental heat flow diagram

with the interior fully lined with acid-resistant brick.

Boiler Plant

Three of the four steam generators are required to develop full output from two turbine generators, thus providing one spare for both the present and the ultimate installation. Steam generation is at 875 psig and 900 F, with each boiler having a continuous generating capacity of 400,000 lb per hour with a four hour peak rating of 440,000 lb per hour. The steam generator is of the radiant type with water-cooled furnace, a small amount of convection surface, primary and secondary superheater sections with external attemperator temperature control, an economizer and a regenerative type air preheater. Fuel oil or natural gas may be burned in six combination wide-range mechanical atomizing burners located in the front wall of each furnace. The burner wind box is sealed in the east wall of the station, thus permitting an enclosed firing aisle for operating convenience. The remainder of the boiler is outdoors. Each boiler is provided with one motor-driven forced and one motor-driven induced draft fan. Fans are operated at constant speed with automatic control of air volume and draft obtained from inlet vanes or louvers and outlet dampers. To avoid corrosion in the flue gas ducts from the low flue gas temperatures which may prevail for long periods under spinning reserve operation, a steam air preheater with automatic damper control has been provided in a by-pass around the regenerative air preheater. At low loads, air flow will be divided between the two heaters, and with the steam air heater relieving a part of the heating burden on the regenerative preheater, flue gases will leave the latter at a higher temperature.

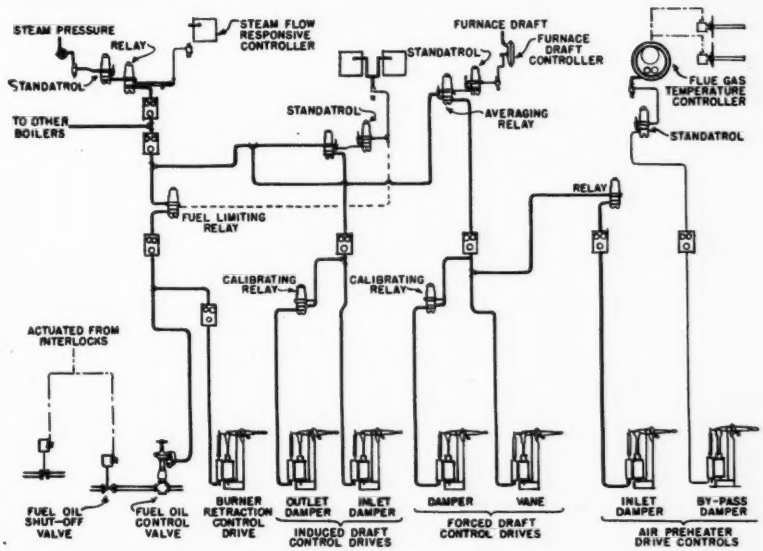

Fig. 5. Fundamental combustion control diagram

Control of steam temperature at the superheater outlet is maintained by an attemperator taking steam from between two stages of the superheater. In order to provide rapid response to quick turbine load pickup, the temperature control is of the two-element type, employing both combustion air flow, as a measure of boiler output, and controlled steam temperature. The air flow element in responding more rapidly than the temperature element will immediately adjust the attemperator controller to correspond to the change in steam flow, while the slower responding steam temperature element will reset the control to standard.

Although soot blowing on a boiler employing oil or gas as a fuel does not present a comparable problem to one burning coal, because of the outdoor installation, full automatic, sequential, air-operated soot blowers have been employed. Each boiler is provided with four retractable and seventeen rotary units em-

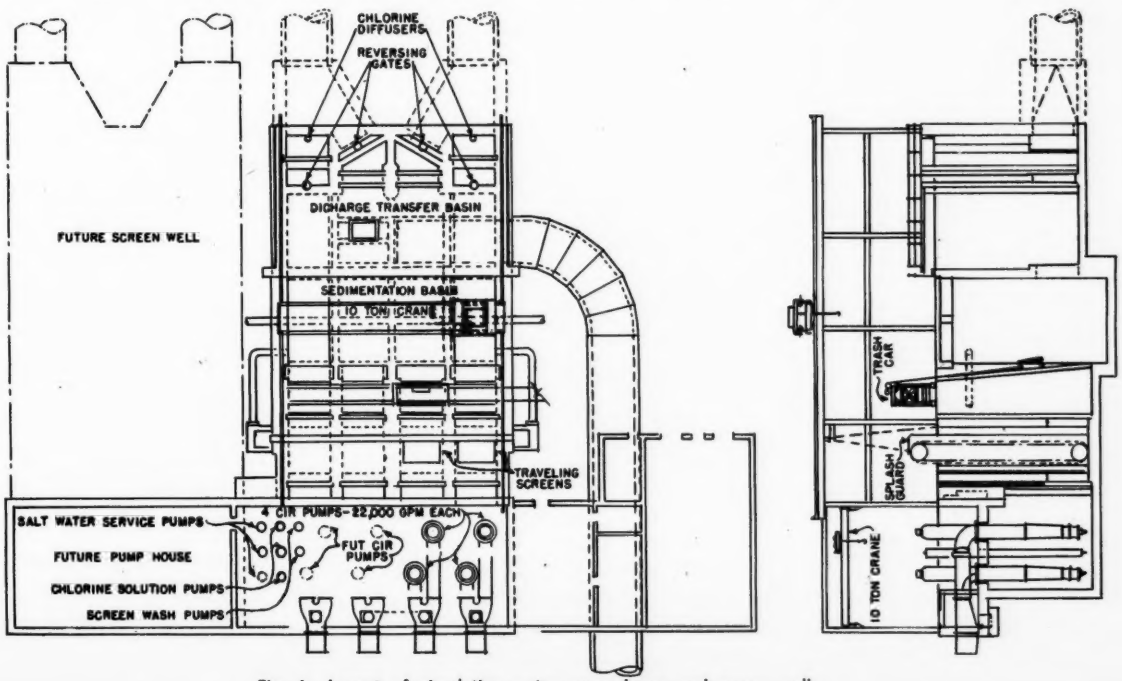

Fig. 6. Layout of circulating water pump house and screen well

PRINCIPAL POWER PLANT EQUIPMENT—REDONDO STEAM STATION
SOUTHERN CALIFORNIA EDISON COMPANY

TURBINE-GENERATORS

Turbine-generator No. 1 — Westinghouse Elec. Corp.

Turbine-generator No. 2—General Elec. Co. 60,000 kw, 850 psig, 900 F, 1.5 in. Hg abs turbine, 4 points of extraction, 3600 rpm, 70,588 kva, 13,800 v, 60 cycles, 3 phase, hydrogen-cooled generator. Main exciter direct connected.

House turbine generator — Westinghouse Elec. Corp.
7500 kw, 850 psig, 900 F, 3600 rpm, quick starting, noncondensing turbine with 6000 kw, 80% pf, 3 phase, 60 cycles, 2400 v air-cooled generator and direct connected exciter.

Centrifugal purifier for turbine oil, 300 gal per hr—The Sharples Corp.

2—Turbine oil conditioners, 540 gal per hr—Bowser, Inc.

2—Condensers, Ingersoll-Rand Co., divided water box, surface type, 42,500 sq ft, 2 pass, each with:
2—Steam jet air ejectors—Ingersoll-Rand Co.

2—Vertical condensate pumps, 1000 gpm, 100 ft TDH, 1750 rpm, motor driven—Ingersoll-Rand Co.

2—Horizontal condensate booster pumps, 1000 gpm, 360 ft TDH, 1750 rpm, motor driven—Ingersoll-Rand Co.

2—Vertical, 2 speed, circulating water pumps, 22,000 gpm ,40 ft TDH, 880 rpm, motor driven—Ingersoll-Rand Co.

Hogging jet—Ingersoll-Rand Co.

2—Condensate coolers, 1370 sq ft—C. F. Braun & Co.

STEAM GENERATING EQUIPMENT

4—Boilers, 400,000 lb per hr, 3-drum, radiant furnace type, 875 psig, 900 F, The Babcock & Wilcox Co., each with:
Superheater, 14,720 sq ft, attemperator control; **Water-cooled furnace**, 3612 sq ft; **Economizer**, 5820 sq ft; **Regenerative type air preheater**, 62,400 sq ft, The Air Pre-Heater Corp.; **6—burners**, combustion gas and oil—Peabody Engineering Corp.; **Soot blowers**—Diamond Power Specialty Corp.; **Water columns**—Diamond Power Specialty Corp.; **Safety valves**—Manning, Maxwell & Moore, Inc.; **Blow-off valves**—Yarnall-Waring Co.

4—Steam air heaters, 1730 sq ft—Aerofin Corp.

4—Forced draft fans, 133,000 cfm at 17.5 in. S.P. and 1190 rpm—B. F. Sturtevant Division.

4—Induced draft fans, 235,000 cfm at 12.0 in. S.P., 400 F and 695 rpm—B. F. Sturtevant Division.

Flue and duct work—Union Steel Co.

CONDENSATE AND FEEDWATER SYSTEM

7—Boiler feed pumps, 785 gpm, 1100 psi, 3550 rpm—Bryon-Jackson Co.

6—Boiler feed pump motor drives, 700 hp—Elliott Co.

Boiler feed pump turbine drive — Terry Steam Turbine Co.

6—Closed feedwater heaters:
2—1st point, 1320 sq ft
2—3rd point, 2130 sq ft
2—4th point, 2130 sq ft—C. F. Braun & Co.

2—Deaerators — 2nd point extraction — Worthington Pump and Machinery Corp.

4—Evaporators and 2 evaporator condensers—Westinghouse Electric Corp.

2—Evaporator feed heaters—Elliott Co.

Boiler feedwater control equipment, 3 element type—Bailey Meter Co.

Deaerator water level regulating equipment—The Swartwout Co.

Evaporator water level regulating equipment—Fisher Governor Co.

Closed feedwater heater drainage controls—The Swartwout Co., Fisher Governor Co.

Zeolite water treatment plant—The Permutit Co.

PIPING, VALVES AND FITTINGS

General piping contractor, fabrication and erection—Midwest Piping Supply Co., Inc.

Insulation contractor—Marine Engineering & Supply Co.

Gate, globe and check valves—The Chapman Valve Mfg. Co., Edward Valves, Inc., and Pacific Valve & Pump Co.

Plug valves—Merco-Nordstrom Valve Co.

Circulating water butterfly valves—Henry Pratt Co.

Nonreturn valves (Boiler)—Edward Valves, Inc.

Nonreturn valves (Turbine extraction)—Atwood & Morrill Co.

Steam pressure reducing valves and desuperheaters—The Swartwout Co.

Pipe line safety valves—Manning, Maxwell & Moore, Inc.

3-way by-pass valves—C. F. Braun & Co.

Miscellaneous valves—Manning, Maxwell & Moore, Inc., Yarnall-Waring Co., Ruggles-Klingemann Mfg. Co., and Howard Supply Co.

Expansion joints
Rubber—U. S. Rubber Co.
Copper—E. B. Badger & Sons

Pipe line strainers—Elliott Co.

Drainers—Atwood & Morrill Co.

Pipe line air filters—Dollinger Corp.

Steam traps—Yarnall-Waring Co., Armstrong Machine Works

PUMPS

Salt water, vertical type—Byron-Jackson Co.
2—Service, 1000 gpm, 100 ft TDH, 1750 rpm, motor driven
2—Screen wash, 1400 gpm, 275 ft TDH, 1750 rpm, motor driven
3—Chlorinator, 600 gpm, 225 ft TDH, 1760 rpm, motor driven

2—Distilled water, 1200 gpm, 250 ft TDH, 3500 rpm, motor driven—Ingersoll-Rand Co.

2—Cooling water, 450 gpm, 155 ft TDH, 3500 rpm, motor driven—Ingersoll-Rand Co.

4—Evaporator feed, 65 gpm, 170 ft TDH, 3500 rpm, motor driven—Ingersoll-Rand Co.

2—Service water, 600 gpm, 230 ft TDH, 3500 rpm, motor driven—Ingersoll-Rand Co.

4—Heater condensate, vertical, 290 gpm, 510 ft TDH, 1750 rpm, motor driven—Byron-Jackson Co.

5—Fuel oil, 1175 rpm, 35,000 lb per hr, 733 psi TDH, motor driven—Sier-Bath Gear and Pump Co., Inc.

Insulating washing, motor driven—Ingersoll-Rand Co.

2—Lubricating oil transfer, motor driven—Ingersoll-Rand Co.

Fire, 1500 gpm, 125 psi, motor driven—Worthington Pump and Machinery Corp.

Fire, 500 gpm, gasoline engine driven—Hale Fire Pump Co.

Insulating oil transfer, motor driven—Ingersoll-Rand Co.

Sump pumps, motor driven—Byron-Jackson Co., Yeomans Bros., and Peerless Pump Co.

TANKS

2—Fuel oil storage, 100,000 bbl capacity—Southwest Welding & Mfg Co.

2—Distilled water, 1 service water and 2 transformer oil—Lacy Mfg. Co.

2—Deaerator overflow flash—Vulcan Pipe & Eng. Co.

3—Detector for fuel oil heater condensate contamination—Joshua Hendy Corp.

3—Lubricating oil storage—American Pipe & Steel Corp.

Evaporator blow-off—Vulcan Pipe & Eng. Co.

Boiler blow-off—Vulcan Pipe & Eng. Co.

2—Cooling water and 2 cooling water return—American Pipe & Steel Corp.

INSTRUMENTS AND CONTROLS

Combustion control—Bailey Meter Co.

Low pressure condensate and boiler feedwater control and metering equipment—Bailey Meter Co.

Steam controls for fuel oil heaters—Bailey Meter Co.

Evaporator steam flow controls — Bailey Meter Co.

Flowmeters—Bailey Meter Co.

Pressure gages—Helicoid Gage Div.

Industrial thermometers — Palmer Thermometers, Inc.

Pressure recorders—Bailey Meter Co.

Oxygen recorders—Leeds & Northrup Co.

Smoke density recorders—Leeds & Northrup Co.

Temperature recorders — Brown Instrument Div.

pH recorders—Leeds & Northrup Co.

Conductivity recorders—Leeds & Northrup Co.

Liquid level indicators—Bailey Meter Co.

Boiler drum level recorders—Bailey Meter Co.

Boiler drum level indicators — Yarnall-Waring Co.

Mercurial barometer and vacuum gages—Precision Thermometer & Instrument Co.

Boiler steam purity determination equipment—W. H. and L. D. Betz Co., and Leeds & Northrup Co.

Dial thermometers—Foxboro Co.

Contamination detectors—Ess Instrument Co.

Sight flow indicators—Fischer & Porter Co.

Tank level controls—The Swartwout Co.

ELECTRICAL EQUIPMENT

Telephone equipment — Automatic Electric Sales Corp.

Transformers 23,333 kva—General Electric Co.

69 kv oil circuit breakers—Kelman Electric and Mfg. Co.

Switches—General Electric Co.

2300 v motor controls and switches—General Electric Co.

Selector switches of push button stations—General Electric Co.

Distribution transformers 37½ kva—General Electric Co.

Station service transformers — Pennsylvania Transformer Co.

Instrument transformers — Westinghouse Electric Corp.

Switchboards — General Electric Supply Co.

Electric elevators—Otis Elevator Co.

2400 v station service metalclad switchgear—I-T-E Circuit Breaker Co.

Potential transformers 66 kv—Westinghouse Electric Corp.

Generator leads cable—The Kerite Co.

Frequency control equipment—Leeds & Northrup Co.

Gage boards — National Cornice Works, Inc.

Automatic oscillograph equipment—William Miller Co.

MISCELLANEOUS

Structural steel—Consolidated Steel Corp.

2—Stacks — Alphons Custodis Chimney Construction Co.

Circulating water tunnels—Macco Corp.

4—Circulating water tunnel gates—Consolidated Steel Corp.

Trash racks and stop logs—Pacific Iron & Steel Co.

Trash rack rake—S. Morgan Smith

3—Traveling water screens—Chain Belt Co.

Chlorination equipment—Wallace & Tiernan Products, Inc.

Air compressors
Service—Ingersoll-Rand Co. and Chicago Pneumatic Tool Co.
2—Control—Ingersoll-Rand Co.

Dredging bucket—Harnischfeger Corp.

Fuel oil heaters—C. F. Braun & Co.
2—suction—2020 sq ft
2—primary—1330 sq ft
4—secondary—1830 sq ft

Trash baskets—C. E. Howard Co.

150-ton turbine room crane — Whiting Corp.

2—10-ton cranes for pump houses and screen well—Shepard-Niles Crane and Hoist Corp.

Monorail hoists—Chisholm-Moore Hoist Corp.

Supplementary chemical feed equipment—Proportioneers, Inc.

Insulating oil filter press and oven—General Electric Co.

2—Heat exchangers for gland sealing and cooling, 1730 sq ft—Southwestern Eng. Co.

ploying steam obtained from the boiler drum reduced to 600 psig pressure.

Combustion Control System

Most of the station mechanical automatic control, including the combustion control system, is air-operated. Air is supplied from two control compressors of the nonlubricated cylinder type with an automatic emergency tie from the station service air system.

The combustion control system has been especially designed for emergency load pickup and is illustrated in Fig. 5. The control master is of the two-element type responsive both to totalized steam flow from all operating boilers and to steam pressure. The various controls which respond to impulses from the master are thus made continually responsive to the totalized steam flow, while the slower acting master pressure regulator resets the controlled value of the steam pressure to standard. The master control impulse is carried direct to the fuel control valve, to the induced draft fan inlet louvers and outlet dampers for volume control and to the forced draft fan inlet vanes and outlet dampers for draft control. Thus the required quantities of fuel and air are delivered simultaneously in response to change in steam flow, while the slower acting fuel-air ratio controller readjusts the relative quantities of fuel and air to the standard value, and while the furnace draft controller resets the furnace draft to standard. Accuracy in measurement of combustion air flow is assured through utilizing a pair of special Venturi sections in the boiler secondary air duct rather than employing the draft loss across a portion of the boiler setting. Under quick pickup, the heat input to the furnace will temporarily increase faster than the resulting steam output, and for this reason the fuel-air ratio is controlled rather than the steam-air ratio. The control drives are of a special high speed type with large air supply lines to insure quick response.

Fuel System

Initial operation of the steam station will be on fuel oil. Arrangements are being made to utilize a supply of natural gas which is to be made available in the near future.

Fuel oil is stored in two 100,000 bbl tanks. From these tanks after passing through suction heaters, the oil is pumped by four high pressure, high capacity, screw type pumps through high pressure secondary heaters located outdoors direct to the boilers. For simplicity in design, no "day storage" tanks are provided. Normally the number of fuel oil pumps in operation will be proportional to the load requirements. To assist in quickly and automatically bringing additional fuel oil pumps into service on quick load pickup from spinning reserve operation, a contact-making, totalizing type oil flowmeter and automatic recirculation control have been installed. The flowmeter automatically starts up additional pumps in response to steam load demand. Since the pumps are of the positive displacement type, the oil flow increases in appreciable increments as additional pumps are put on the line, and automatic recirculation control serves to equalize the increased pumping rate with the actual demand for fuel oil. For reliability, the fuel oil system is sectionalized and installed in parallel from storage tanks to boilers.

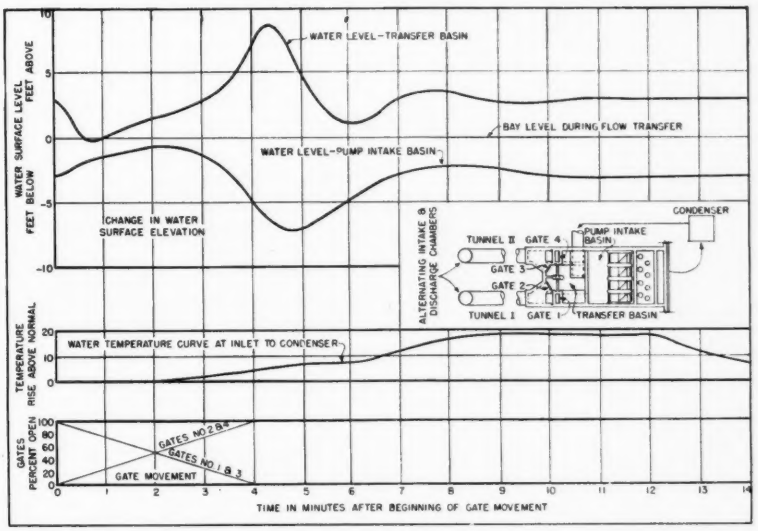

Fig. 7. Characteristics of circulating water system during flow transfer

The necessity for quick pickup from spinning reserve operation requires that all six burners on each boiler be in operation even at minimum load, since there will be insufficient time for lighting off additional burners. In order to provide a controllable oil burning range of 20 to 1, the Peabody wide-range, constant differential system has been employed. Fuel oil supplied to the boilers is controlled by a regulating valve, responsive to the combustion control in each boiler oil supply line. This valve admits oil to the suction of a motor-driven, constant differential fuel oil pump, one of which is installed at each boiler, and which superimposes 300 psi upon the controlled pressure at its suction. At full load, oil will be supplied to the combustion control regulating valve at about 650 psi. To provide the 20 to 1 range of control required, this valve will regulate the oil pressure in the suction of the differential pump through a range of about 600 to 20 psi. With a 300 psi pressure differential added by the pump, oil will, therefore, be supplied to the burners over a range of about 900 to 320 psi.

This burner sprays into the furnace a quantity of oil equivalent to the difference between the amount of oil supplied to the burner tip and the amount withdrawn through a return outlet from the burner. The burner contains a set of tangential slots followed by a whirling chamber from which that part of the oil required for combustion is discharged through an orifice into the furnace, while the balance is returned to the suction of the constant differential pump. The pressure drop across the tangential slots controls the atomization of the oil, while the pressure in the whirling chamber, or the pressure drop through the orifice, controls the amount of oil sprayed into the furnace and hence, the firing rate. By the action of the constant differential pump, a constant pressure drop of 300 psi is held across the slots at all ratings, thus insuring the same degree of atomization at both minimum and full loads. Since the differential pressure added by the pump to that of the oil discharged from the combustion control regulating valve is deducted in these atomizing slots, the whirling chamber or orifice pressure is essentially the same as that controlled by the regulating valve, so that the quantity of oil fired is proportional to that regulated by the combustion control. The lower the pressure in the whirling chamber, the less is the flow of oil through the burner orifice and the greater the return flow to the pump suction. While the flow to the burners is essentially constant, the return from the burners is less than the foregoing by that which enters the furnace, and this difference is equal to the net make-up of oil admitted by the combustion

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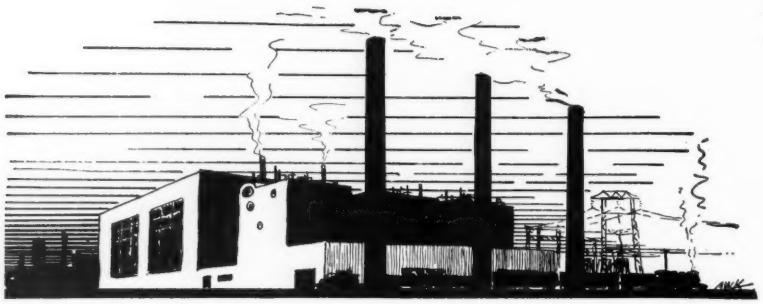

What Do You Mean By Thermal Efficiency?

By ALLEN KELLER

Assistant Division Engineer, Turbine Engineering Division
General Electric Company, Lynn, Masachusetts

OUTPUT-OVER-INPUT is not a satisfactory definition of efficiency in most cases. A better definition of efficiency is *useful output* divided by *valuable input*. Even this definition must be further qualified before it is applicable in many cases. These differences may not appear to be significant, but they are, and many of the problems encountered in power plant design, operation, and cost accounting are greatly simplified if the concept of efficiency is thoroughly understood.

Let's see why the simple definition "efficiency equals output-over-input" is not satisfactory. First, we will go through a few short steps of deductive reasoning in which we will derive an accurate definition of efficiency.

(1) In school the writer learned that efficiency is defined as

$$\text{Efficiency} = \frac{\text{Input}}{\text{Output}}$$

(2) In school (pre-atomic age) the writer also learned of the "law of conservation of energy." In accordance with this physical law, energy can neither be created nor destroyed, therefore the total energy output of any apparatus must equal the total energy input.

(3) (1) and (2) above, if taken together, indicate that the efficiency must always be 100 per cent.—This is not true.

(4) Our next thought was to change the definition of efficiency to read

$$\text{Efficiency} = \frac{\text{Input}}{\text{Useful Output}}$$

(5) This equation also can be misinterpreted and lead to an incorrect result.

The electrical energy output of a generator would certainly ordinarily be considered as useful output; if it were not, no one would be willing to pay good money for a turbine-generator set. On the other hand, part or all of the output of a generator may be used internal to a power plant to drive essential auxiliaries. Such electrical energy does not represent useful output for the plant as a whole.

It thus appears that the phrase "useful output" must be limited to include only output useful in places *external* to the apparatus under consideration.

(6) From the above, it appears that a good working definition of efficiency can be stated as follows:

$$\text{Efficiency} = \frac{\left\{\begin{array}{l}\text{Total energy output available to and useful for processes external to the apparatus under consideration.}\end{array}\right\}}{\left\{\begin{array}{l}\text{Total valuable energy input from sources external to the apparatus under consideration.}\end{array}\right\}}$$

Those who read the series of articles on Modern Turbines which we published between September 1937 and April 1939 may remember Allen Keller since he wrote three of the articles of that series. Mr. Keller has been a turbine specialist at the Lynn works of G. E. for many years and few men in this country are better versed in the fundamentals underlying turbine design than he. On basic principles his viewpoint is always refreshing—he has an enviable knack of getting at the root of things, of explaining simply, and effectively. Now, again, he comes forth with a discussion of thermal efficiency that is both interesting and useful to every power engineer whether his interest is in operation or design. As he points out, when you are designing an industrial power plant you have to start in the factory; you have to know exactly how much steam and how much electricity it will need. These constitute the USEFUL output of the power plant and these provide the basic data for the design of the plant. This sounds simple enough but there has been much confused thinking on this whole subject and Mr. Keller does much to clarify it.

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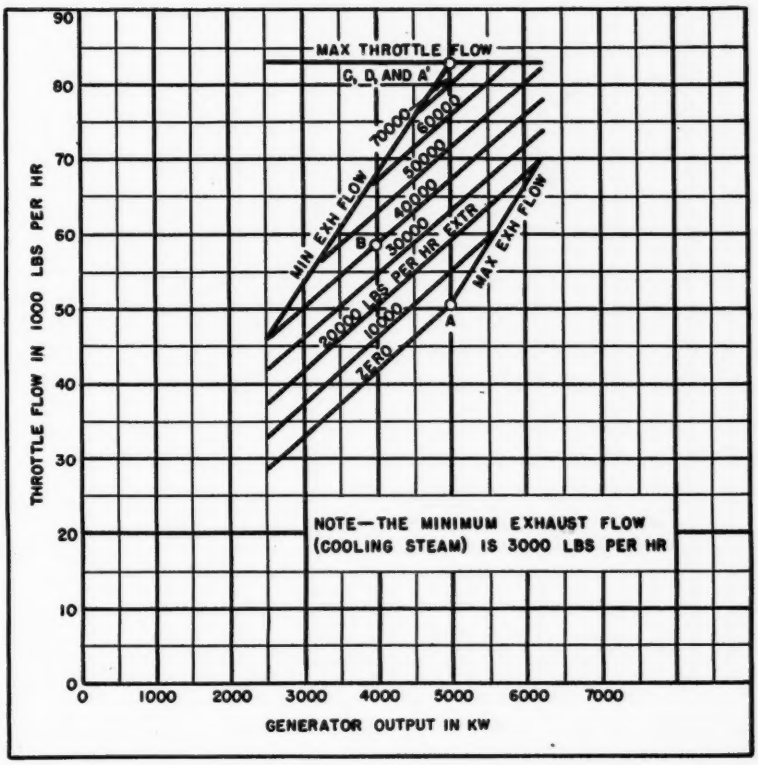


Fig. 1. Performance chart of a condensing, automatic extraction turbine generator set rated at 5000 kw. Conditions: 400 psig, 750 F TT, 2 in. Hg Abs, automatic extraction, 5 psig

The above analysis thus leads directly to the correct realization that you cannot talk about the efficiency of a turbine or a power plant as a thing all by itself; you can evaluate its efficiency only after you have specified the electrical power and heat demands of the factory or city in which the power plant is to be operated. A given industrial power plant may be quite efficient today. Next year the electrical power and steam demands *of the factory* may have changed so as to make the power plant very inefficient. The change in efficiency was not caused by a change in the power plant itself, it is the same plant; it was caused by changes in manufacturing processes outside the power plant.

If you wish to design an efficient industrial power plant, you cannot start inside the power plant. You must start in the factory. The factory may need electricity only, it may need steam only, more probably it will need both. These constitute the *useful output* of the power plant you propose to design. The *valuable input* will usually be quite easy to specify; it will probably be coal, oil, or gas. You now have the basic data to go inside the power house building and specify power plant equipment which can efficiently deliver the desired useful output. (If you're foresighted, you'll also look ahead a few years and estimate how your factory requirements may change and try to design your plant so these changes will not make it obsolete.)

The above concepts seem so simple and fundamental as to make any discussion of them redundant. Even so, experience shows that many intelligent persons are quite hazy and unorganized in their thinking on the subject. For example, you may be concerned with power house cost accounting and have fussed and fumed about how to pro-rate your power house costs between electricity generated and steam supplied to process. Admittedly, each power plant must be considered as a spe-

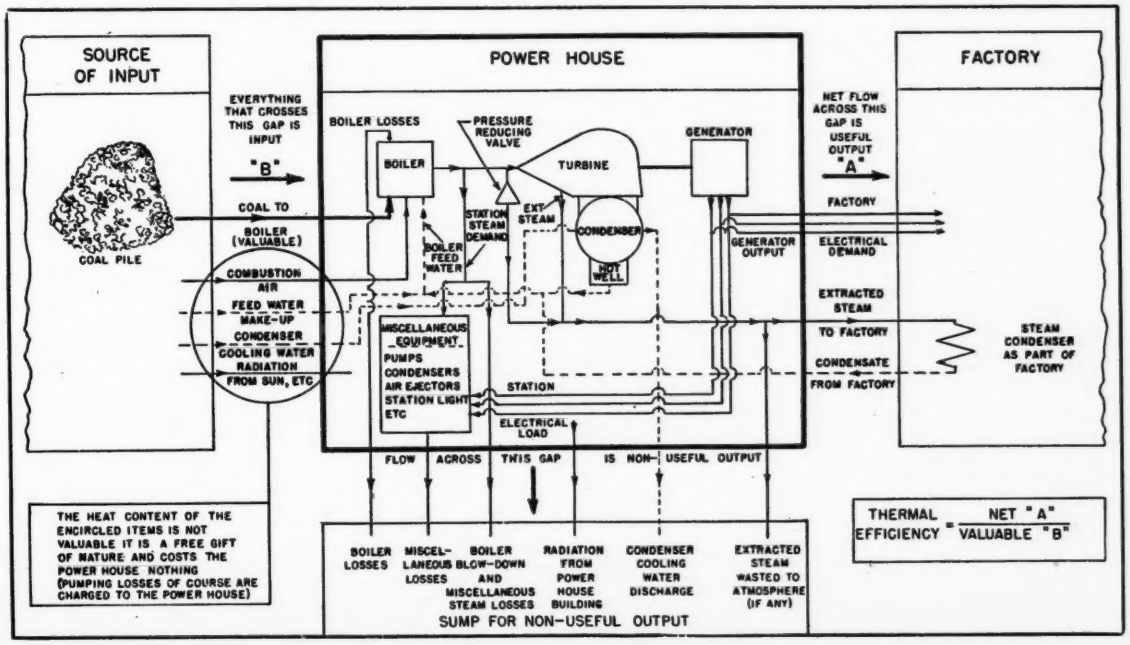


Fig. 2. Diagramatic sketch of a simple industrial power plant (pumps and miscellaneous devices not detailed)

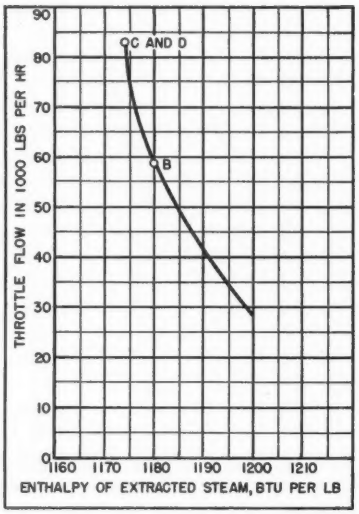


Fig. 3. Approximate enthalpy of extracted steam for a 5000 kw condensing, automatic extraction turbine generator set. Conditions; 400 psig, 750 F TT, 2 in. Hg Abs. Automatic extraction, 5 psig

cial case and no general rules can be written to cover all cases. This article will not give you a direct answer to this problem, but this writer believes that the problem will become somewhat easier if you start off with a clear conception of what constitutes the useful output of the plant and then pro-rate the valuable input to the various outputs on what seems to be an equitable basis.

Now for some examples.

Turbine Performance Curve

Figure 1 is a performance curve for a typical industrial turbine-generator set. The turbine is of the condensing, automatic extraction type. The set is rated 5000 kw and the turbine is designed for steam conditions of 400 psig—750 F at the throttle, and 2 in Hg absolute pressure at the condenser flange. The turbine is also designed to permit extraction of steam at an essentially constant pressure of 5 psig.

When operated zero extraction (the lower line on the chart), the turbine passes all flow to the condenser and the only "normally useful" output is the electrical power delivered by the generator. On the other hand, the set may be operated elsewhere on the chart with some or almost all of the throttle steam being extracted at a pressure of 5 psig. In this case the output (presumably useful) will consist of both the electrical energy delivered by the generator and the heat energy contained in the extracted steam.

Now, the question is, "About what will be the thermal efficiency of the power plant in which this turbine is the prime mover?"

In answering this question, our previous conclusions have indicated that we cannot calculate the efficiency of the power plant by going directly (figuratively speaking) into the power house. We must first go into the factory and establish what the power plant can deliver that will be useful to the factory. The power house is to get no credit for anything it delivers that the factory cannot use. That is just common sense.

Let us assume four separate cases for what we find in the factory. These may be called "A," "B," "C," and "D" and are as follows:

Case	Factory Requirements: Electric Power	Steam at 5#G
A	4900 KW	0 #/hr.
B	3900 KW	40,000 #/hr.
C	4900 KW	80,000 #/hr.
D	4900 KW	100,000 #/hr.

Sketch of Simple Industrial Power Plant

There is one other feature of the efficiency equation as stated in numbered paragraph (6) which should now be discussed, that is the significance of the word "valuable" in front of the input which appears in the denominator. To do this we will refer to Fig. 2 which is a diagrammatic sketch of a power plant in which the turbine of Fig. 1 has been installed. You need not trace out the steam, water, and electricity flow

(Text continued on page 116)

Table I. Summary of thermal efficiency calculations

Item No.	ITEM	Unit of Measurement	How Obtained	VALUES FOR VARIOUS CASES A	B	C	D	A[1]
101	Type of Turbine Operation			Straight Condensing	Condensing Extraction	Condensing Total Extraction With Factory Steam and Electrical Loads Balanced	Condensing Total Extraction With Factory Steam Demand Greater than Electrical Demand	Non-Condensing Generation of Power With No Factory Steam Demand
	FACTORY REQUIREMENTS							
102	Electric Power	KW	From Factory	4900	3900	4900	4900	4900
103	Steam at 5#G Pressure	#/HR.	From Factory	0	40,000	80,000	100,000	0
	POWER HOUSE OPERAT. DATA							
104	Generator Electric Output	KW	=(205)[a]	5000	4000	5000	5000	5000
105	Turbine Extraction Flow at 5#G	#/HR.	=(206)	0	40,000	80,000	80,000	80,000
106	5#G Process Steam Taken from Boiler by Press. Reducing Valve	#/HR.	=(215)	0	0	0	20,000	0
107	5#G Extraction Steam Blown to Atmosphere by Power House	#/HR.	See note (b), Table (II)	0	0	0	0	80,000
108	Turbine Throttle Flow	#/HR.	=(207)	50,400	58,500	83,000	83,000	83,000
109	Boiler Steam Flow	#/HR.	(106)+(208)+(213)+(229)	53,400	61,500	86 000	106,000	86,000
110	Flow to Turbine Condenser	#/HR.	=(208)	50 400	18,500	3000	3000	3000
	PLANT OVERALL THERMAL EFFICIENCY DATA							
111	Useful Output—Electric Energy to Factory	Btu/HR.	=(209)	16,700,000	13,300 000	16,700,000	16,700,000	16,700,000
112	Useful Output—Steam to Factory	Btu/HR.	=(219)	0	39,400,000	78,300,000	102,200,000	0
113	Useful Output—Total	Btu/HR.	(111)+(112)	16,700,000	52,700,000	95,000,000	118,900,000	16,700,000
114	Valuable Input—From Coal Pile	Btu/HR.	=(233)	86,100,000	93,800,000	128,000,000	157,600,000	142,700,000
115	Plant Overall Thermal Efficiency	Non-Dimensional	(113)/(114)	0.194	0.562	0.742	0.754	0.117

(a) This notation indicates that item (104) is copied as item (205) from table (2).

Table II. Detailed steps in thermal efficiency calculations

Item No.	ITEM	UNIT OF MEASUREMENT	How Obtained	VALUES FOR VARIOUS CASES A	B	C	D	A[1]
	FACTORY REQUIREMENTS							
201	Electric Power	KW	From Factory	4900	3900	4900	4900	4900
202	5#G Process Steam	#/HR.	From Factory	0	40,000	80,000	100,000	0
	POWER HOUSE REQUIREMENTS							
203	Electric Power	KW	From Assumption	100	100	100	100	100
204	Steam at 400#G—750°F	#/HR.	From Assumption	3000	3000	3000	3000	3000
	TURBINE—GENERATOR OPERATING CONDITIONS							
205	Generator Electrical Output	KW	(201)+(203)	5000	4000	5000	5000	5000
206	Turbine Extraction Flow at 5#G	#/HR.	(202)	0	40,000	80,000	80,000[a]	80,000[b]
207	Turbine Throttle Flow	#/HR.	Fig. (1) at (205) & (206)	50,400	58,500	83,000	83,000	83,000
208	Turbine Flow to Condenser	#/HR.	(207)—(206)	50,400	18,500	3000	3000	3000
	POWER HOUSE USEFUL OUTPUT CALCULATIONS							
209	Heat Equivalent of Useful Electrical Output	Btu/HR.	3413 × (201)	16,700,000	13,300,000	16,700,000	16,700,000	16,700,000
210	Enthalpy of 5#G Extrac. Steam	Btu/#	Fig. (3) at (207)	—	1180.2	1174.2	1174.2	—
211	Enthalpy of Factory Steam Condensate at 5#G	Btu/#	Steam Table at 19.7 Psia	—	195.3	195.3	195.3	—
212	Heat Available to Process Per Pound of Extracted Steam	Btu/#	(210)—(211)	—	984.9	978.9	978.9	—
213	Extracted Steam Flow to Process	#/HR.	From Assum.	0	40,000	80,000	80,000	0
214	Total Useful Output From Extracted Steam	Btu/HR.	(212) × (213)	0	39,400,000	78,300,000	78,300,000	0
215	Boiler Flow Going to Factory Through Press. Reduc. Valve	#/HR.	From Assum.	0	0	20,000	0	0
216	Enthalpy of Boiler Steam	Btu/#	Steam Table at 414.7 Psia & 750°	1389.0	1389.0	1389.0	1389.0	1389.0
217	Heat Available to Process Per Pound of Boiler Steam	Btu/#	(216)—(211)	—	—	—	1193.7	—
218	Total Useful Output Represented by Boiler Steam to Factory	Btu/HR.	(215) × (217)	0	0	0	23,900,000	0
219	Total Useful Output of All Steam to Factory	Btu/HR.	(214)+(218)	0	39,400,000	78,300,000	102,200,000	0
220	Total Useful Output	Btu/HR.	(209)+(219)	16,700,000	52,700,000	95,000,000	118,900,000	16,700,000
	VALUABLE INPUT CALCULATIONS							
221	Enthalpy of Condens. at Hotwell	Btu/#	Steam Table at 2" Hg	69.1	69.1	69.1	69.1	69.1
222	Heat Added by Boiler Per Lb. of Condensate From Hotwell	Btu/#	(216)—(221)	1319.9	1319.9	1319.9	1319.9	1319.9
223	Heat Added by Boiler to Condensate From Hotwell	Btu/HR.	(208) × (222)	66,500,000	24,400,000	4,000,000	4,000,000	4,000,000
224	Enthalpy of Condensate Returned by Factory	Btu/#	Steam Table at 210°F	—	178.0	178.0	178.0	—
225	Heat Added by Boiler Per Lb. of Condensate Ret. from Factory	Btu/#	(216)—(224)	—	1211.0	1211.0	1211.0	—
226	Heat Added by Boiler to Condensate From Factory	Btu/HR.	(202) × (225)	—	48,400,000	96,900,000	121,100,000	—
227	Enthalpy of Feedwater Make Up	Btu/#	Steam Table at 60°F	28.1	28.1	28.1	28.1	28.1
228	Heat Added by Boiler Per Lb. of Make Up Flow	Btu/#	(216)—(227)	1360.9	1360.9	1360.9	1360.9	1360.9
229	Excess of Boiler Flow Over Combined Flows to Turbine Exhaust and to Factory	#/HR.	=(204) (d)	3000	3000	3000	3000	83,000[c]
230	Heat Added to Boiler for Flow (229)	Btu/HR.	(228) × (229)	4,100,000	4,100,000	4,100,000	4,100,000	113,000,000
231	Total Heat Added to Steam by Boiler	Btu/HR.	(223)+(226) +(230)	70,600,000	76,900,000	105,000,000	129,200,000	117,000,000
232	Boiler Efficiency	Non-Dimensional	From Assum.	0.820	0.820	0.820	0.820	0.820
233	Total Val. Input From Coal Pipe	Btu/HR.	(231)/(232)	86 100,000	93,800,000	128,000,000	157,600,000	142,700,000
234	Plant Thermal Efficiency	Non-Dimensional	(220)/(233)	0.194	0.562	0.742	0.754	0.117

NOTES. (a) For case (D), the factory needs 100,000 lb per hr of steam at 5 psig, but Fig. (1) shows that 80,000 lb per hr is all the Turbine can deliver. The additional 20,000 lb per hr must be taken from the boiler by pressure reducing valve.
(b) For case (A^1) the factory requires no 5 psig steam but we are assuming that the power house elects, for some reason or other, to generate the 5,000 Kw of electrical power by blowing 5 psig, extracted steam to atmosphere. This case illustrates the generation of power by non-condensing Turbines when there is no demand for process steam.
(c) For case A^1, the boiler flow is 83,000 lb per hr higher than the combined flows to Turbine exhaust and factory because of the 80,000 lb per hr of extraction steam being wasted to atmosphere and the 3,000 lb per hr of power house steam uses and losses.
(d) In Line 230 we are assuming that the enthalpy of the condensate from the 1500 lb per hr of steam used in the power plant for miscellaneous purposes is the same as that of the make-up water.

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Nuclear Energy and Our Vanishing Fuel Resources

Unless you can accept "the long view" this article will probably not contribute much to your better understanding of our present use of our fuel resources. There is still ample coal for a great many years to come and the oil supply is not going to run out next week or next year. It is, however, going to run out some day and so is our coal supply and it is with this fact in mind that this article was written. In view of the fact that, now, we may be able to replace much of our use of coal and oil by nuclear energy, it seems only sensible that we should begin to consider seriously the development of nuclear power plants for both stationary and mobile purposes

By **ANDREW W. KRAMER**, Editor, Power Generation

IN A RECENT BOOK entitled, "Our Plundered Planet," Fairfield Osborn makes compellingly clear that, in the march toward oblivion, mankind has placed itself near the head of the procession. As the only animal that deliberately destroys the environment on which its survival depends, man has used his magnificently developed forebrain to heighten the effectiveness of that destruction. The result, as Mr. Osborn shows, is a shambles; while populations increase, the means of satisfying their needs steadily diminishes.

By various random samples the book shows parallel developments of the relationship between man and his environment on the five continents and Australia. Nearly everywhere man's destruction of vegetation has disrupted the hydrologic cycle, with resultant soil erosion, floods, siltation, falling water tables, vanishing wildlife, and, though the author does not stress the point, falling human living standards. As the earth disease progresses, more and more of the organism-environment is involved, and treatment and cure become more difficult and costly.

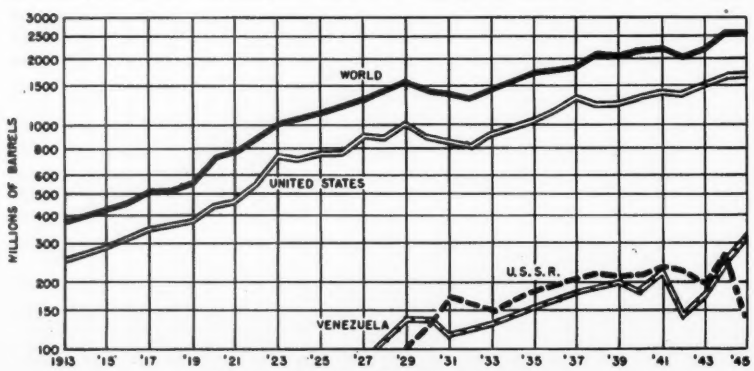


Fig. 1. Total World Production of Petroleum

Mr. Osborn gives many examples of how the selfish motives of small groups have succeeded in destroying irreplaceable natural resources. Among other things he reminds us of the role of the Mesta—the Spanish Wool Growers' Association—in wrecking their country. Nature, he points out, gives no blanket endorsement to the profit motive. What is needed is world-wide planning—adequate and intelligent appraisal of our resources and the development of programs for conserving them. Mr. Osborn sets forth, eloquently, that science is not yet ready

to synthesize the adequate environment visualized by some technicians and many economists and he recognizes the fact that cultural limitations prevent the use of modern technology in countries dominated by backward, illiterate and exploited populations.

This book should be widely read; it tells perhaps the most important story of our day and it tells it well. There are, however, several matters to which more attention might have been given. One of these concerns population control and the other our vanishing fuel resources. Mr. Osborn repeatedly mentions excessive populations but does not suggest doing anything about checking their increase. He makes a convincing plea for better use of the land and from this the uninformed reader might conclude that improved land-use would take care of mankind, even after we were piled three deep. This, of course, is not true; direct checks on human reproduction are at least as indispensable as forest management and contour plowing.

Our Fuel Resources Are Not Unlimited

The depletion of our fuel resources is another question to which Mr. Osborn gives little specific attention, yet, it is a very important one. Of course, there are those who insist that there is still plenty of fuel and that there is no cause for worry. Eugene Holman, president of Standard Oil Company told the annual meeting of the American Petroleum Institute of November, 1946, that there is no danger of the U. S. running out of liquid fuels "for centuries to come." Just how many centuries Mr. Holman had in mind was not disclosed but the fact remains that we are using up our liquid fuel resources at a rate greater than ever before and while there are still great reserves, we are not finding new reserves at as great a rate as we once did; and we are using them up at an ever increasing rate. Despite the great amount of oil, the last two winters have seen the fuel oil situation so tight that in certain parts of the country rationing was necessary.

The situation with respect to coal is somewhat better. There still seems to be a great deal of coal in the world but here also our consumption is increasing to such an extent that predictions as to the probable length of time that our coal reserves will last are little more than guesses. At present, we are using around 600,000,000 tons of coal a year in this country alone but if we start converting coal into synthesis gas, we may need 1,200,000,000 tons a year. And our use of coal as a raw material for various products will increase steadily with the years. Coal serves as the basis for some 200,000 chemical products. Remember, it takes from 6 to 10 pounds of coal, originally, to produce a pair of nylon stockings. So, as pointed out by K. C. Richmond, The Editor of Coal-Heat recently, every time you pass 250 women or so on the street, you might say, "There goes another ton of coal." It takes about 33 pounds of coal to help produce the apparel the average family buys per year, not including shoes, which take 3 pounds. Thus the birth of some three and one-half million babies per year in this country adds some 13,700,000 tons of coal to our annual requirements.

In the public utility field, outside of the hydro, oil or gas territory every extra kilowatt-hour added to the power load means an increase of about 1.5 pounds of coal. At the Edison Electric Institute Convention in Atlantic City in June of this year, Gwilym A. Price, president of the Westinghouse Electric Corp. predicted that in the next 10 years the total annual sales of electric power will rise 72 per cent to 374 billion kilowatt-hours. This is an increase of 156 billion kilowatt-hours, equivalent to an increase in coal consumption of 117,000,000 tons annually.

These are random figures—they may be off somewhat but the implications are clear; our coal and oil reserves are being used up at an almost exponential rate. True, for the next 10, 50 or 100 years there probably will be ample to go around even in face of a tremendous population growth but if, as we say we are, we are so concerned about our children and our children's children, we would do well to take stock and ask ourselves, how are *they* going to live.

The Devil Take the Hindmost

The fact is, of course, we don't care as much about the fate of our children's children as we say we do. The devil take the hindmost may be perhaps an overstatement of our creed but by and large we give little thought to those who may come after us. Their fate and the things that influence their fate are of little concern to us. In the ultimate analysis it doesn't matter whether the human race perishes as a consequence of its own stupidity or from the gradual running down of the solar system but if we accept the viewpoint that we are intelligent beings, we cannot but at least give lip service to the continued existence of what we have been conditioned to believe is our Christian civilization.

Indeed, much that we could do now would affect our own comfort and security. Early in June there was a disastrous flood on the Columbia River, almost completely wiping out the town of Van Port, Oregon. Figures released shortly after the disaster indicated a total damage of 145 million dollars. This is practically the overall cost of Grand Coulee Dam, about which there was so much criticism when it was first proposed. While Grand Coulee Dam and Bonneville and other dams on the Columbia do have a slight effect in controlling floods they were not built for flood control and even if they were, they alone would not be enough. Not until the Columbia basin is developed as a whole in the manner of TVA can we expect to do away, once and for always, with the destructive floods along the course of this great river. The regional development of the Tennessee Valley has shown that if the problem is handled properly, considering a great area as a unit, floods can be eliminated.

Similar considerations apply to the conservation of our coal and oil

(Continued on page 122)

What the Power Engineer Needs to Know About

The Pneumatic Spreader Stoker

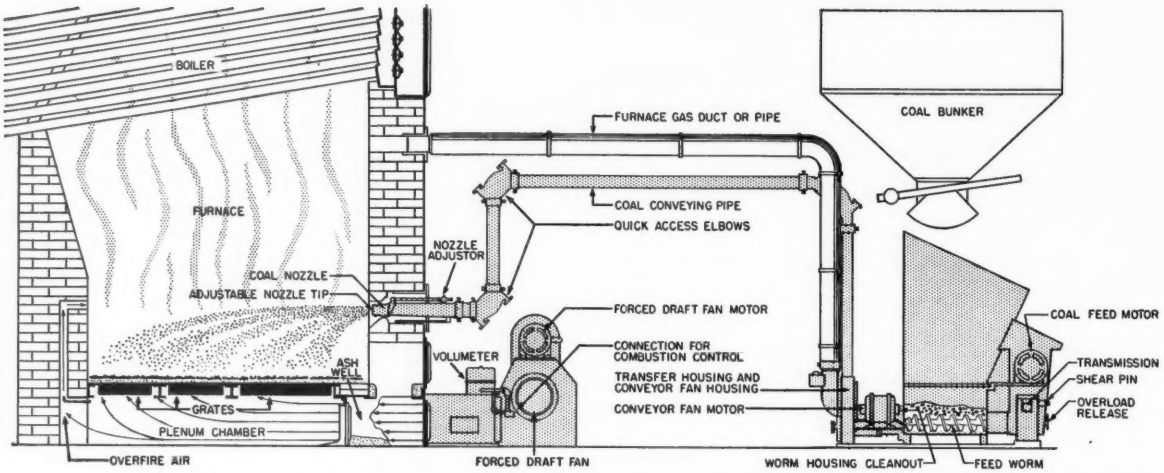
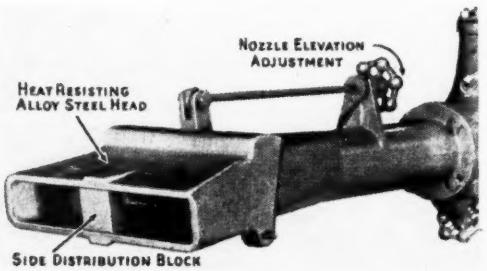


Fig. 1. General arrangement of hopper feed type pneumatic spreader stoker elements, showing coal feeding mechanism at the right, pneumatic conveying system, coal nozzle and arrangement of grates, forced draft fan, and ash removal

THE PNEUMATIC SPREADER STOKER fires steam size coal to a boiler furnace by conveying it in a stream of air (or mixed air and furnace gas) to one or more nozzles in the wall of the furnace, through which it is injected to fall on a stationary or dumping grate, where it burns. This type of stoker has been installed to fire all types of steam generating units, with outputs from 5000 lb to as high as 50,000 lb of steam per hr. With recent increase in stoker capacity to 4000 lb an hour of coal per nozzle, steam outputs above 100,000 lb per hr are contemplated.

In another form of stoker, often

Fig. 3. View of coal nozzle, showing details of elevation adjustment and side distribution block



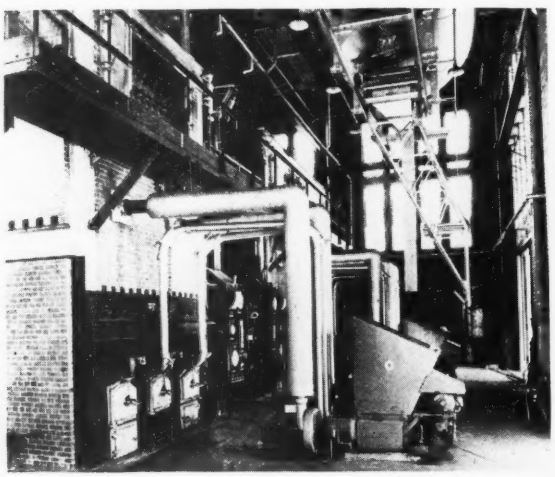


Fig. 2. Typical pneumatic spreader stoker installation. Each of two 2000-sq ft straight-tube, cross-drum, box-header, water-tube boilers fired by dual-nozzle stoker. Coal 14,350 Btu per lb, ash 7.5%, ash softening temperature 2280 F. Overall efficiency 79.6%. Forced draft fans behind boilers; no economizer, air preheater, water wall. Fly-ash reinjected at rear wall. Evaporation 11.45 lb per coal as fired. Weigh larry loads stoker hoppers; automatic combustion control

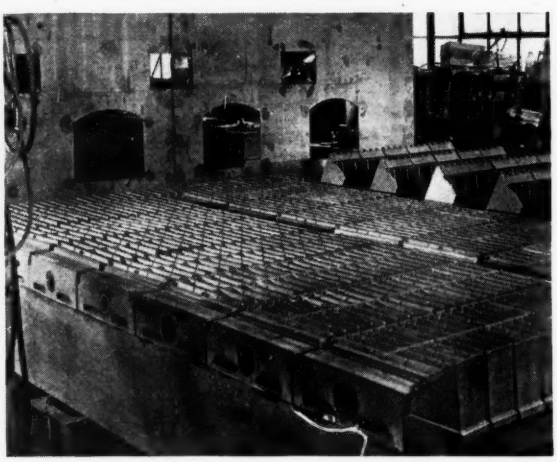


Fig. 4. Shop view of 3-nozzle installation with 3 sections of dumping grates. Each section has separate plenum chamber below and is fired by an individual nozzle

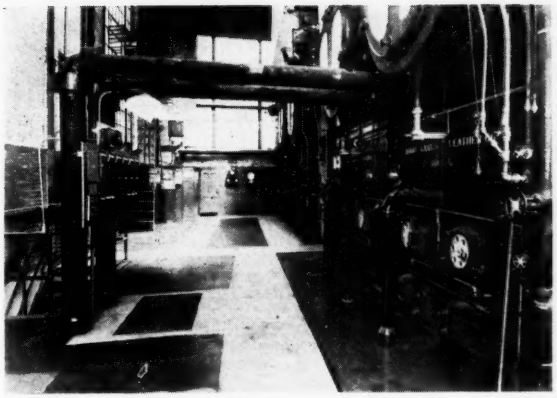


Fig. 5. For these two HRT boilers, each designed for 17,000 lb steam per hr, single-nozzle, bin-feed pneumatic stokers installed at bottom of bin, below firing floor, lift coal 32 ft. Boilers converted from oil. Saving $25,000 in first cost. Fuel, Pocohantas nut and slack. Overall efficiency 73%, CO_2 13.5%, flue gas exit temperature 530 F. Automatic combustion control

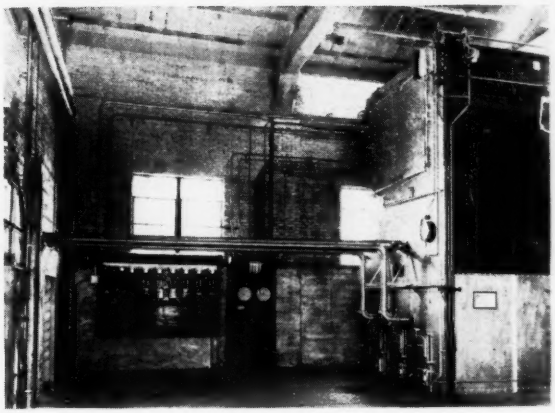


Fig. 6. Two separate stokers, installed under existing coal bunker at left, feed coal direct from bunker to one 250-hp, 115-psi cross-drum water tube boiler. Replace former mechanical stokers, reduce steam cost from 54 to 20 cents per 1000 lb, with increased load. Automatic combustion control. Overall efficiency 71.8%; CO_2 12%

classed as a pneumatic spreader, the coal is fed by a short screw conveyor to a plate just inside the furnace entrance, and blown from this plate into the furnace by a jet of air entering through a nozzle. This type of stoker will be described more fully in a separate article in a future issue.

The type of pneumatic stoker discussed here, as shown in the illustrations, and as manufactured by the Iron Fireman Corp., consists of four fundamental elements:

(1) A feeder mechanism for feeding and metering of coal; (2) a pneumatic conveyor system for delivering coal to the furnace; (3) provisions for combustion of coal in the furnace; (4) automatic control of combustion and stoker operation. The arrangement of these elements is as shown in Fig. 1.

How Stoker May Be Installed

Individual pneumatic spreader stoker units are built in single and dual nozzle designs. Units burning up to 4,000 lb of coal per hour are built in single nozzle designs. Dual nozzle stokers are built up to 3,200 lb per hour. Two or more nozzles may serve one boiler, as required for the total burning rate. As high as six nozzles have been installed in a furnace. These were installed in two tiers of three nozzles, three above and three below, as in Fig. 7.

The stoker feeder may be located almost anywhere near the boiler, at any angle and as much as 50 ft or more from the boiler front. It may even be located in a separate room, and, in at least one case, as shown in Fig. 5, it is installed 30 ft below the firing floor.

Bunker or bin feed models convey the coal directly from the bunker or storage pile without the necessity of filling a hopper.

Hopper type stokers are often recommended where coal-handling equipment is already installed or where the tonnage is small. Bin or bunker feed stokers, however, have been well applied in cases where the tonnage is sufficient to involve a considerable handling cost, but not high enough to warrant the cost of coal-handling equipment. Even in new plants with tonnage justifying coal-handling equipment, investment costs have been reduced by using the pneumatic principle of coal handling incorporated in this system. See Fig. 8.

Other factors to be considered are cleanliness of the boiler room and conservation of boiler room space.

A typical example of the way in which this type of pneumatic spreader stoker can be installed, entirely outside the boiler room and in such a way as to provide the most convenient arrangement for the space available, was given in the article Power Plant Improvements at Stanley Furniture Company, POWER GENERATION, April 1948 issue.

This stoker is designed to burn the entire range of high and low rank bituminous coal, regardless of the ash fusion temperature. The stoker also is highly adaptable to very small sized coals, such as ¼ in to 0, for pneumatic distribution makes possible the spreading of fine coal over the full length of the grate. Such sizes and ranks of coals are usually highly economical fuels to burn. Higher grade bituminous coals are highly suitable; and excellent

(Continued on page 126)

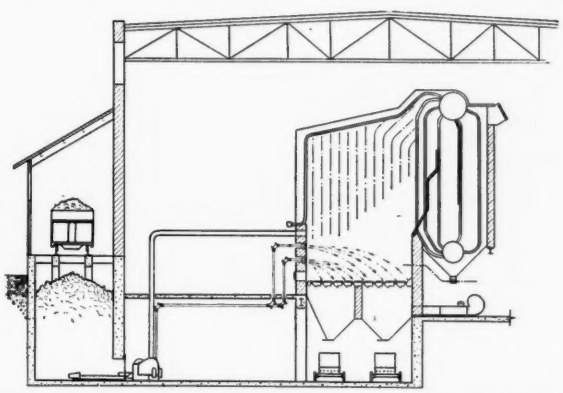


Fig. 7. Typical bin-feed pneumatic spreader stoker installation, showing coal conveyed from bunker below railroad track. Two tiers of 3 nozzles each for distribution over grates 15 ft long. No other coal-handling equipment required

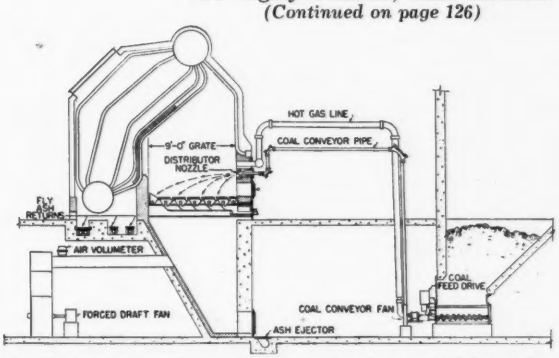


Fig. 8. Installation of pneumatic spreader stoker with integral furnace boiler, capacity 40,000 lb steam per hour, 200 psi. Unit fired by 3 bin-feed stokers; no other coal-handling equipment required

Trends in Modern Feedwater Conditioning Equipment

Part II. How to Select a Water Conditioning System. Before deciding on the method of water conditioning for a specific plant, a number of factors must be carefully considered. These include such items as the cost of the initial equipment, chemical and operating costs, heat value of the blowoff, and the skill required to operate the plant. The following case histories clearly explain how these factors are evaluated to arrive at a wise decision.

By S. B. APPLEBAUM President, Liquid Conditioning Corporation

THE TREND TOWARDS higher operating pressures and temperatures has increased the limitations on total solids, alkalinity, and silica in boiler feedwater. To meet these requirements, many changes in water conditioning methods and equipment have had to be made. Impurities and conditions, which had been previously ignored at lower pressures, now have to be seriously considered.

Silica and aluminum in the boiler salines are now recognized as major impurities because of the formation of silica deposits in steam turbines and the sodium-alumino-silicate-scale in boilers. In addition to reducing hardness, silica, and aluminum, it is also advisable to build up an excess of phosphate in the boiler saline to act as a barrier against even small amounts of calcium forming hard scale.

Almost complete deaeration of dissolved oxygen and carbon dioxide and adequate reduction of bicarbonates and carbonates in the feedwater must be practiced to eliminate the threat of corrosion. Removal of these gases also reinforces the need for low alkalinity now called for by the ABMA limits to prevent carryover.

Selection of the proper method for any given case requires considerable experience and sound judgment. The following points should be carefully considered in important cases before making a decision.

1. Predict the chemical results (analysis of the treated water) by the various methods being considered.
2. Calculate the chemical operating costs.
3. Estimate the cost of the installation.
4. Determine whether the operating personnel have sufficient training and skill to operate the plant.
5. Calculate the boiler blowoff required to keep under the limit of total solids or silica in the boiler saline and evaluate the heat wasted in the blowoff, considering the heat balance and how the heat of the blowoff can be absorbed efficiently into the feed system.

As regards relative investment, this depends on the raw water analysis and on the size of the plant. In general, the following may be considered the usual order of investment with average waters for fair sized plants starting with the lowest and progressing downward to the highest investment:

1) Sodium Zeolite—particularly if raw water does not have to be preclarified. If coagulation and filtration must be added ahead of the Sodium Zeolite, it may become more expensive than Hot Lime Soda.
2) Sodium Zeolite plus acid—same remarks as for No. 1.
5) Cold Lime Soda
7, 9) Hot Lime or Hot Phosphate alone
3, 4) Hydrogen Zeolite
6) Cold Lime plus Zeolite
8) Hot Lime Soda plus Hot Phosphate
10) Demineralizing
11) Demineralizing plus anion unit for SiO_2 removal

The following case histories may be helpful in showing how the final decision was reached:

	Ppm Total Solids as the Ions	Operating Cost ¢/M Gals. Including Phosphate	Blowoff in % Mu to Maintain 3500 Ppm	Approx. Oper. Cost Per Yr. Incl. Blowoff	Price of Equipment Not Erected
1) Hot Process, 2-stage, plus Acid Feed, Deaerator	83	3.1	2.4	$18,635.	$85,000.
2) H_2Z, Na_2Z, Degasifier Deaerating Heater	34	1.54	0.98	9,124.	65,000.
3) Na_2Z Acid, Degasifier, Deaerating Heater	128	1.9	3.8	12,445.	50,000.
4) H_2Z, Degasifier, Caustic, Deaerating Heater	37	2.4	1.07	14,085.	75,000.

Table IV. Comparison of initial investment and operating costs by the various methods considered in Case I

CASE 1 — OPERATING RESULTS SHEET — TABLE V — Date

Name

Address

LIQUON

Identification:
A - Raw
B - After Hot Process plus acid plus Deaerator
C - After H_2Z, Na_2Z plus Deaeration
D - After Na_2Z plus acid plus Deaerator
E - After H_2Z plus NaOH plus Deaerator

	CONSTITUENT		Analysis in PPM as	A	B	C	D	E	F
CATIONS	Calcium	(Ca^{++})	$CaCO_3$	75	1	1	1	1	
	Magnesium	(Mg^{++})	$CaCO_3$	5	1	1	1	1	
	Sodium	(Na^{+})	$CaCO_3$	10	58	22	78	22	
	Hydrogen=FMA	(H^{+})	$CaCO_3$						
			$CaCO_3$						
TOTAL CATIONS			$CaCO_3$	90	60	24	90	24	
ANIONS	Bicarbonate	(HCO_3^{-})	$CaCO_3$	76	10	10	10	10	
	Carbonate	(CO_3^{--})	$CaCO_3$		0	0	0	0	
	Hydroxide	(OH^{-})	$CaCO_3$		0	0	0	0	
	Sulfate	(SO_4^{--})	$CaCO_3$	8	38	8	74	8	
	Chloride	(Cl^{-})	$CaCO_3$	6	6	6	6	6	
			$CaCO_3$		6				
TOTAL ANIONS			$CaCO_3$	90	60	24	90	24	
Total Hardness			$CaCO_3$						
Methyl Orange Alkalinity			$CaCO_3$						
Iron, Total			Fe						
Carbon Dioxide, Free			CO_2						
Silica			SiO_2	4	2	4	4	4	
Turbidity									
Color									
pH									

Table V. Tabulation of the chemical operating results by the various methods considered in Case I

Identification:

A - Raw
B - After Hot Lime Soda and Integral Deaerator
C - After Sodium Zeolite & Deaerator

	CONSTITUENT		Analysis in PPM as	A	B	C	D
CATIONS	Calcium	(Ca^{++})	$CaCO_3$	63	15	1	
	Magnesium	(Mg^{++})	$CaCO_3$	47	10	1	
	Sodium	(Na^{+})	$CaCO_3$	63	63	171	
	Hydrogen=FMA	(H^{+})	$CaCO_3$				
			$CaCO_3$				
TOTAL CATIONS			$CaCO_3$	173	88	173	
ANIONS	Bicarbonate	(HCO_3^{-})	$CaCO_3$	150	0	150	
	Carbonate	(CO_3^{--})	$CaCO_3$	0	65	0	
	Hydroxide	(OH^{-})	$CaCO_3$	0	0	0	
	Sulfate	(SO_4^{--})	$CaCO_3$	8	8	8	
	Chloride	(Cl^{-})	$CaCO_3$	15	15	15	
			$CaCO_3$				
TOTAL ANIONS			$CaCO_3$	173	88	173	
Total Hardness			$CaCO_3$	110	25	2	
Methyl Orange Alkalinity			$CaCO_3$	150	65	150	
Iron, Total			Fe	0.1	0.1	0.1	
Carbon Dioxide, Free			CO_2	4	0	4	
Silica			SiO_2	45	10	45	
Turbidity							
Color							
pH							

OPERATING COST

CHEMICALS	lbs per 1000 gal.	* Chemical cost cents per lb.	Chemical cost—cents per 1000 gallons
Hot Lime			1.5¢
Sodium Zeolite			2.0¢

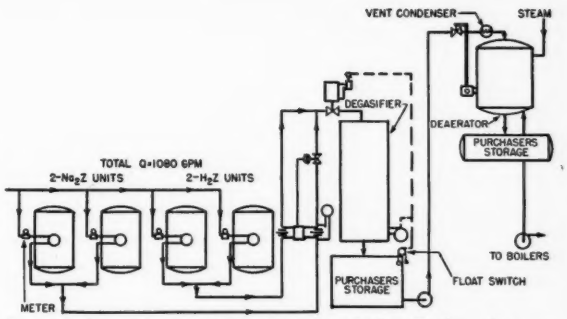


Fig. 2. Flow diagram of the Hydrogen-Sodium-Zeolite plant selected for Case I

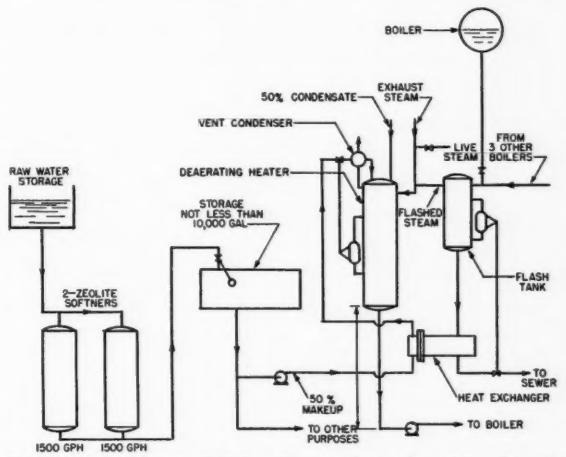


Fig. 3. Flow diagram of Sodium-Zeolite plant selected for Case II

* Identification:

A - Raw Water
B - After Hydrogen Sodium Zeolite
C - After 2-stage Hot Process plus acid

	CONSTITUENT		Analysis in PPM as	A	B	C	D
CATIONS	Calcium	(Ca^{++})	$CaCO_3$	20	1	1	
	Magnesium	(Mg^{++})	$CaCO_3$	10	1	1	
	Sodium	(Na^{+})	$CaCO_3$	92	61	111	
	Hydrogen=FMA	(H^{+})	$CaCO_3$				
			$CaCO_3$				
TOTAL CATIONS			$CaCO_3$	122	63	113	
ANIONS	Bicarbonate	(HCO_3^{-})	$CaCO_3$	74	15	20	
	Carbonate	(CO_3^{--})	$CaCO_3$	0	0	20	
	Hydroxide	(OH^{-})	$CaCO_3$	0	0	0	
	Sulfate	(SO_4^{--})	$CaCO_3$	8	8	28	
	Chloride	(Cl^{-})	$CaCO_3$	40	40	40	
	Phosphate		$CaCO_3$			5	
TOTAL ANIONS			$CaCO_3$	122	63	113	
Total Hardness			$CaCO_3$	30	2	2	
Methyl Orange Alkalinity			$CaCO_3$	74	15	40	
Iron, Total			Fe				
Carbon Dioxide, Free			CO_2		10	.0	
Silica			SiO_2	8	8	1.5	
Turbidity							
Color							
pH							

OPERATING COST

CHEMICALS	lbs per 1000 gal.	* Chemical cost cents per lb.	Chemical cost—cents per 1000 gallons
Hydrogen-Sodium Zeolite			3.9¢/M gals
Hot Process			3.15¢/M gals

Table VI. Above: Chemical results and oper. costs by methods considered in Case II

Case II Table VII. Left: Chemical results and oper. costs by methods considered in Case III

Case 1

Capacity of water treating plant 1000 gpm or 500,000 lb per hr

Boiler pressure 300 psi

Makeup 100 per cent

No economizers

Condensate will be used for industrial process purposes and condensate lines will be long so that low CO_2 in the steam is important. Therefore, a low alkalinity of 10 ppm in final effluent was desired. A comparative study was made of:

1) Sodium Zeolite plus acid plus Degasifier plus Deaerator
2) Hydrogen and Sodium Zeolite plus Deaerator
3) Hydrogen Zeolite plus caustic plus Deaerator
4) Hot Lime Soda plus Hot Phosphate plus acid plus Deaerator (Integral in 1st stage)

All of these were designed to give

	Cost of Equipment Not Erected	ppm CO_2 in steam 50% makeup	Blowoff % of makeup for evaporation
Sodium Zeolite plus Deaerator plus Blowoff	$6000.	60	5.1%
Hot Lime Soda with separate condensate heater	9000.	12	2.6%

Table VIII. Right: Comparison of initial investment, CO_2 in the steam, and percent blowoff by methods considered in Case II

the same low alkalinity of 10 ppm. The chemical operating results are shown in Table V and Table IV and gives the comparative chemical operating cost, boiler blowoff, operating cost per year, including chemicals and value of the heat of the blowoff, and price of the water conditioning equipment (not erected).

The decision in this case was for Hydrogen and Sodium Zeolite plus Deaerator because:

1) The purchaser preferred to operate the Hydrogen Zeolite rather than the acid feed.
2) Lowest blowoff
3) Lowest operating cost
4) The alkalinity after Hydrogen Zeolite exceeded 20 per cent of the total solids but they decided this ABMA limitation could be neglected and still good quality steam would be produced.
5) Silica was not important because of low boiler pressure. Therefore, Hot Process which reduced silica was not needed and it was the most expensive to install and the operating cost was higher.

Case 2

Capacity of water treating plant 25,000 lb per hr
Boiler Pressure 150 psi
Makeup 30 to 75 per cent
No economizers
Fairly long condensate return lines

A comparative study was made of Hot Lime Soda vs Sodium Zeolite.

Table VI gives the chemical results and chemical costs and Table VIII gives the investment, CO_2 in the steam and per cent blowoff.

The decision was in favor of Sodium Zeolite because:

1) Much less skill required in the operation of the plant. This was the determining factor.
2) Lower investment
3) The purchaser decided to risk the corrosion of the condensate return lines due to the higher CO_2 in the steam. He will leave space alongside the Sodium Zeolite units for a future Hydrogen Zeolite plant to reduce the alkalinity later if severe corrosion is encountered.
4) Silica reduction was unimportant due to low boiler pressure.

Case 3

Capacity of water treating plant 100,000 gph or 833,000 lb per hr
Boiler pressure 900 psi
Turbines will be used
No economizers
Makeup 70 per cent
Raw water was clear

A comparative study was made of Hydrogen plus Sodium Zeolite and of 2-stage Hot Process Lime Soda plus Hot Phosphate plus acid including Deaerators in both methods.

Table VII gives the chemical operating results and chemical costs and Table IX gives the comparative investment and boiler blowoff.

Table IX. Comparison of initial investment, CO_2 in the steam with 70 percent makeup, and boiler blowoff by the methods considered in Case III

	Cost of Equipment Not Erected	ppm CO_2 in steam with 70% makeup	Boiler Blowoff in % of makeup (for evaporation) to maintain 20 ppm SiO_2 and 1300 ppm T.S.
Hot Process 2-stage	$130,000.	23	8%
Hydrogen Sodium Zeolite Type	100,000.	12	67%

The decision was in favor of the Hot Process mainly because of the fear of silica deposits in turbines. The purchaser felt that 20 ppm of silica in the boiler saline should not be exceeded and the boiler blowoff was excessive to maintain this limit of silica with Hydrogen Sodium Zeolite. To precede the Hydrogen Sodium plant by a cold process silica removal would have cost too much to install and operate. Acid was added after the Hot Process to reduce the pH value to 9.5 to avoid phosphate after reactions and deposits in stage bleeder heaters.

Conclusions

Higher boiler pressures call for lower total solids, lower alkalinity and much lower silica. This had caused a trend in favor of Hydrogen Zeolite to produce the low solids and low alkalinity waters and in favor of 2-stage Hot Process to accomplish the reduction in silica simultaneous with softening the water. Sodium Zeolite plus acid is still a strong contender where simplicity of operation is the all important consideration and where silica reduction is not indicated. A combination of Cold Process lime treatment followed by Sodium Zeolite is a favorite where the raw water is not clear and where silica reduction is required.

The application of the latest method of water treatment thus far developed, viz:—Demineralizing plus anion exchanger silica removal is to be expected soon as a competitor to evaporators. Great interest has been shown in the possibilities of this method by users of high pressure boilers (1200 psi and above) particularly where the makeup is appreciable due to the sale of turbine-bled steam to industrial plants nearby. Thus far, this method has found application by pharmaceutical manufacturers and similar firms to replace distilled water at a fraction of its former cost.

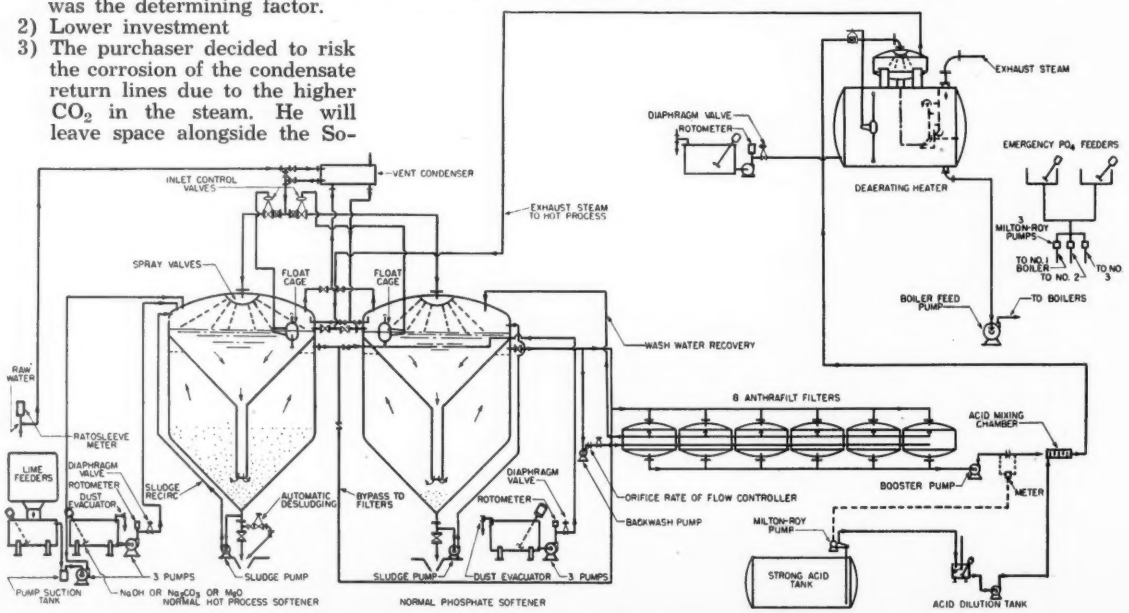


Fig. 4. Flow diagram of the 2-stage Hot Process Lime Soda plant selected for Case III

Taking the Mystery Out of The Amplidyne

Part II*. A typical amplidyne application . . . Current limit . . . Anti-hunt circuit . . . Summary of advantages of the amplidyne . . . Other amplidyne applications . . . Possibilities still untouched

By W. H. WIGINGTON, Jr. Control Engineering Division, General Electric Company, Schenectady, N. Y.

PART I of this article was devoted to a description of the physical and electrical characteristics of the amplidyne generator. Briefly, the amplidyne was found to be a special type of d-c generator requiring extremely small amounts of control or excitation power, and further, possessing the characteristics of high amplification and fast response. Because of these desirable characteristics the amplidyne is applied to a wide variety of control problems. The purpose of this second part of the article is to discuss one such application.

A widely used control system, and one which serves well for illustrative purposes, is the Ward Leonard, or adjustable voltage system. For some applications the adjustable voltage system of control is superior to the constant voltage system of control. If the speed of several motors must be controlled simultaneously, or if a speed range of more than 4 or 5 to 1 is required, or if constant torque is required, then the advantages of Ward Leonard control are easily discernable.

Figure 9 shows a typical amplidyne application in a circuit designed for adjustable voltage speed control of a motor. For simplicity the diagram of Fig. 9 includes only those essential circuit elements required to accelerate the drive from rest under current limit, and then regulate at whatever speed point has been chosen. Deceleration with pump-back current limit, plugging, and reversal are readily obtained in this type of circuit.* It is felt that their inclusion here, however, does not warrant the additional circuit complexity which would be involved.

The circuit under discussion is a regulating system as well as a control system, so it must contain the inherent elements of any regulating system, i.e., a reference quantity against which is measured the momentary value of the controlled quantity, a means of measuring the difference between the standard quantity and the actual quantity, and a method of utilizing this measured difference to change the actual quantity in a manner such that it will more nearly approach the standard quantity.

In the amplidyne circuit of Fig. 9 a standard quantity is obtained by exciting the reference field from a fixed d-c constant voltage. A reliable indication of actual motor speed is obtained by coupling a tachometer generator to the motor shaft. The speed-voltage curve of this tachometer generator is essentially a straight line. Hence, the output voltage of the tachometer generator is a direct function of motor speed, the quantity which is being regulated. The speed quantity is introduced into the regulating circuit by applying the tachometer voltage to the amplidyne control field.

In studying the action of the control and reference fields neglect for the moment the effects of the anti-hunt and current-limit fields. Assume that the amplidyne requires a net excitation of 15 amp turns in order to excite the main generator sufficiently for it to supply rated current to the motor running at rated speed. Assume further that the amplidyne reference field excitation alone amounts to 45 amp turns. Under these conditions the control field circuit will have to be designed so that at rated motor speed the tachometer generator voltage will excite the control field sufficiently for it to produce 30 amp turns. Now, the 45 amp turns of the reference field minus the 30 amp turns of the control field results in the required net amplidyne excitation of 15 amp turns.

Fig. 10 shows how this particular arrangement for obtaining the required net excitation results in introducing forcing action into the regulator. When the control cycle is initiated the reference field builds up to its three-times-normal excitation (45AT) almost immediately. The control field, however, builds up only as fast as the motor accelerates. The curve of resulting net excitation shows clearly that until such time as the motor reaches rated speed the system is subjected to considerable forcing. Effective forcing is shown as a shaded area in Fig. 10. Faster acceleration is obtained as a result of this forcing action.

Figure 10 also shows how this particular reference field-control field combination acts under conditions of impact loading. Assume that the motor received (am) impact load of sufficient intensity to reduce the motor speed by 10 per cent. The speed-voltage curve of the tachometer is a straight line, so the motor speed drop of 10 per cent will be accompanied by a change in amplidyne control field excitation of 10 per cent, or a reduction of three amp turns. While three ampere turns is 10 per cent of the control field excitation of 30 amp turns, it is

*Part I of this article appeared on page 62 of the May 1948 issue.

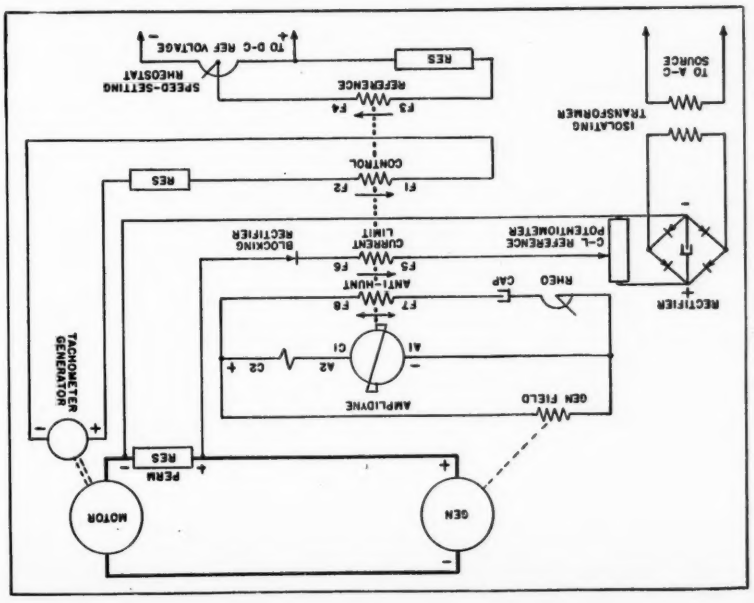


Fig. 9 Ward Leonard speed control using amplidyne with current limit feature

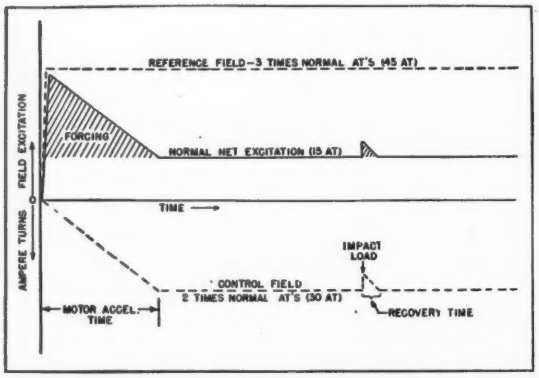


Fig. 10 Forcing effect during conditions of acceleration and impact loading

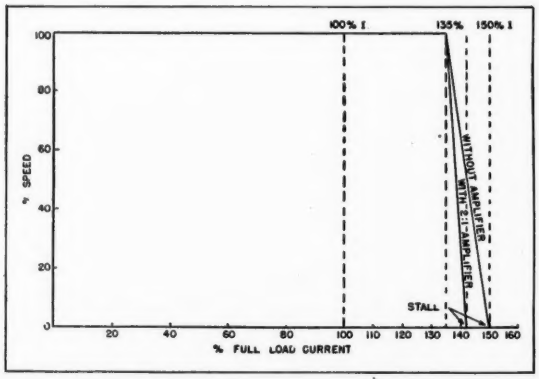


Fig. 11 Typical motor speed-current characteristic resulting from use of basic current limiting circuits

to be noted that three amp turns is 20 per cent of the net amplidyne excitation of 15 amp turns. This relationship is more easily seen by studying the curve of Fig. 10.

Current Limit

In any circuit of this type due consideration must be given to the current-limit feature. Without current limit, for example, and with the forcing employed in this illustration, probably at least 10 times full load current would be circulated through the motor under stalled conditions. Protective devices would, of course, prevent the current from reaching this magnitude. The well designed control system, however, will limit the current under any and all operating conditions to predetermined and preset values. Such a system insures maximum performance within the capabilities of the motor and its associated mechanical drive.

It is interesting to examine the functioning of the current-limit field and its allied circuit. Under stalled conditions the motor cannot generate counter emf. The resistance which limits the flow of current under these conditions consists of two parts: the armature resistances of the Ward Leonard adjustable voltage motor and generator, and the permanent block of resistance which is inserted in that armature circuit to produce a voltage drop for application to the current limit field of the amplidyne.

The armature permanent resistor is usually chosen so that with full load current flowing there will exist across the resistor a drop of 10 v. For purposes of illustration assume that 10 v is sufficient to circulate full load current through the motor alone at standstill. Then under stalled conditions a generator potential of 20 v will be required to circulate full load current through both the motor and the permanent resistor.

A net amplidyne excitation of, say, less than one ampere turn will be required in order to produce enough amplidyne voltage to excite the main generator sufficiently for it to deliver full load current at 20 v. Furthermore, when the motor is at standstill the tachometer generator is not generating voltage and, hence, the control field of the amplidyne is furnishing zero excitation.

Assume now that the commutating ability and the short-time overload characteristics of this particular Ward Leonard set are such that the motor stall current must be limited to 150 per cent of normal full-load motor amperes. An output of about 30 v will be required of the main generator in order to circulate this 150 per cent full load current. In turn, the net amplidyne excitation will have to be, say, one ampere turn. This one ampere turn will have to be the difference in excitation between the reference field and the current-limit field, i.e., if the reference field is excited at a fixed value of 45 amp turns, then the current-limit field will have to be excited to a value of 44 amp turns.

The field current required to produce 44 amp turns in the current-limit field will cause a voltage drop across the current-limit field and its associated rectifier of say 1.5 v. The permanent resistor drop at 150 per cent full load current is 15 v. So if the current-limit field reference potentiometer is set for 13.5 v the necessary 1.5 v potential difference will exist and sufficient current will flow in the current-limit field to excite it to 44 amp turns. The current-limit field excitation is now opposing the 45 amp turns excitation of the reference field to give a net excitation of one ampere turn. And one ampere turn, as was previously decided, is just sufficient to cause 150 per cent current to circulate through the motor under stalled conditions.

Now, if the load is reduced slightly in order to allow the motor to pull out of its stalled condition the tachometer generator will excite the control field a slight amount. This excitation furnished by the control field acts to reduce the net amplidyne excitation which, in turn, ultimately reduces the main motor armature current. The reduction in armature current results in a smaller permanent resistor voltage drop and hence less excitation in the current-limit field. This action continues until an equilibrium point between load, speed, and current is reached. This is illustrated by the speed-current curve of Fig. 11.

Note on the speed-current curve of Fig. 11 that at 100 per cent speed the current may increase to 135 per cent of full load value before the current-limit field comes into play and reduces the motor speed. Above 135 per cent current the permanent resistor drop exceeds the current-limit reference potentiometer drop and current flows in the current-limit field. Below 135 per cent current the potentiometer voltage exceeds the voltage drop of the permanent resistor but current cannot flow due to the blocking rectifier.

For some applications sharper current-limit cutoff is sometimes required. One method of achieving sharper current-limit cutoff is to arrange the circuit so that the current-limit field excitation is a function not only of motor armature current but also of motor speed as indicated by tachometer voltage. Another method is to employ an amplifying exciter (a small amplidyne, usually about 300 watts or less) to "magnify" the voltage drop of the armature permanent resistor.

In the circuit of Fig. 9 the current-limit reference potentiometer was set for 13.5 v. It was shown that for these conditions the current-limit field became effective whenever the armature permanent resistor drop exceeded 13.5 v (corresponding to 135 per cent current). Furthermore, the current-limit field became fully effective (44AT) when 150 per cent current caused a 15 v armature permanent resistor drop. Assume now that a 2:1 amplifying exciter is used. Full-load armature current causes an amplifier output of 20 v. Under these conditions it is necessary to double the current-limit reference voltage so as to make it 27 v. Full current-limit action still requires a 1.5 v differential, or an amplifier voltage of 28.5 v (27 v plus 1.5 v). An amplifier output of 28.5 v corresponds to 142.5 per cent

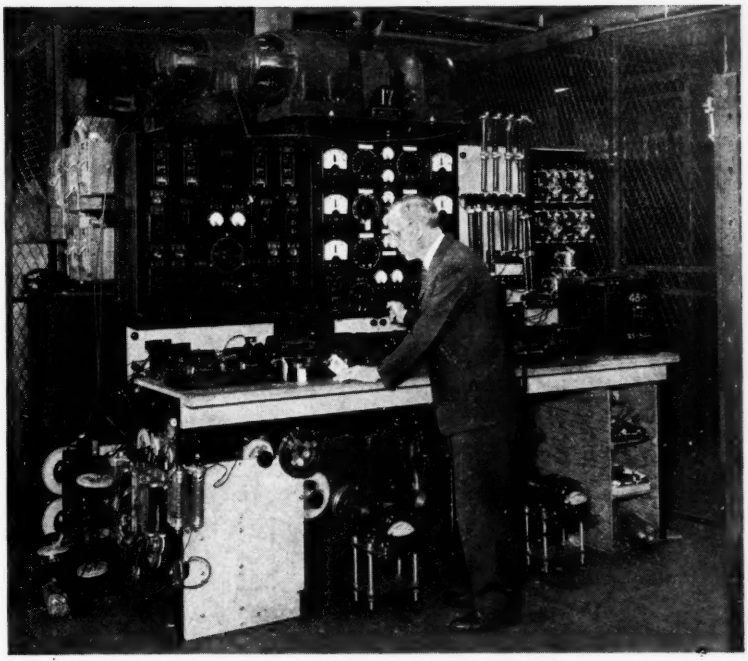


Fig. 12. Laboratory test set-up arranged to simulate vertical-lift-bridge amplidyne synchrotie control

of full-load motor current. Thus, current-limit action is now effective in the range 135 per cent—142.5 per cent full-load motor amperes. Figure 11 shows this condition. Actually the range is not quite as narrow as indicated because in order to circulate 142.5 per cent motor amperes under stalled conditions slightly more than 44 ampere turns is required of the current-limit field.

Refer to the circuit of Fig. 9 and note the method used to obtain a source of reference voltage for current-limit purposes. The isolating transformer serves the following purposes: first it gives an independent source of voltage free from such troublesome effects as sneak circuits back through the d-c shop or control power supply to ground and perhaps eventually to the Ward Leonard armature circuit; second, a transformer inherently provides a certain degree of voltage regulation; and third, the available voltage is readily transformed to the most desirable value.

Anti Hunt Circuit

The circuit of Fig. 9 is a "closed-cycle" control system, i.e., the controlling agency is actuated by some function of the final output in such a manner as to minimize any deviation of the output from an ideal value. All closed-cycle control systems inherently possess a natural period of resonance. For most industrial applications this resonant frequency is of the order of 2 or 3 cycles per second. The natural period of any given system is a function of the combined electro-mechanical inductance and capacitance of the system as a whole. Sustained oscillations, or "hunting," will prevail at this natural frequency provided the amplification is great enough. For most industrial applications the amplification is more than sufficient to support hunting.

It is necessary, therefore, for the circuit designer to provide a method of suppressing oscillations. A typical method of suppressing oscillations is the capacitor anti-hunt system shown in Fig. 9. Resistance and capacitance are connected in series with the anti-hunt field and the combination is connected across the armature of the amplidyne. Under steady-state conditions there is no power transfer to the anti-hunt field. When there is a change in armature voltage, however, the charge on the capacitor must change accordingly. Any change in capacitor charge is accompanied by a current flow. This current acts through the anti-hunt field so as to resist the change in armature voltage. For example, refer to Fig. 9. If the amplidyne C2 terminal suddenly becomes more positive current will flow from F8 to F7, thus making C2 less positive.

The capacitor anti-hunt system is advantageous in that it affords flexibility. A typical regulator might be provided with 12 capacitors of 100 mfd each. By changing from series to parallel connections, or combinations of the two, capacities of from about 8½ to 1200 mfd are readily obtained. The flexibility provided in the anti-hunt circuit allows the system to be adjusted for optimum transient performance.

Use of an amplidyne in a Ward Leonard adjustable voltage speed control system results in the following advantages. The combination of speed regulation with current-limit control, plus the inherent forcing designed into the circuit, results in fast, smooth, and accurate motor response under conditions of acceleration, deceleration, and load changing. The small power involved in controlling the amplidyne fields allows substantial economies in the associated control circuit components. Thus, rheostats, resistors, switches, and control relays may all be selected to handle miliamperes instead of amperes. And, as previously mentioned, the amplidyne itself is just as reliable and trouble-free as any other piece of rotating machinery.

Other Amplidyne Applications

It is not the purpose of this article to attempt detailed discussions of all the more important amplidyne applications, but it is felt that a few such applications should be enumerated. Briefly, they are as follows: voltage control and limit; current control and limit; speed control and limit; positioning; voltage control with current limit; current control with voltage limit; and positioning with voltage and current limit. These are the basic combinations. More specifically, the amplidyne is used for train control as exciters for synchronous generators, direction control for guns and radar, ship propulsion control, train lighting systems, welding control, aircraft control, servo systems, furnace control, electric shovels, mine hoists, saw mills, arc furnace control, crane control, dynamometer control, control of systems, and many other applications.

Conclusion

The amplidyne is not a complicated and mysterious device. Literally thousands of amplidynes have been manufactured and put into service, including those used for military purposes. The amplidyne has for long now been out of the experimental stage, but new and improved uses are continually being sought for and found. For example, Fig. 12 is a photograph of a laboratory test set-up arranged to simulate the operation of a vertical lift bridge with d-c driving motors held in step by a differential selsyn tie in with amplidyne control.

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The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

Air-Cooled Wall Beats Solid Wall at Atlas Brewing Company

When the solid walls of the two boiler furnaces at the Atlas Brewing Co. were completely relined in 1939 and 1940, half of the battery wall between the two boilers was installed as a suspended air-cooled wall. Experience with the two types of construction showed that the solid walls required complete relining every 3 or 4 years, while the air-cooled wall needed only minor repairs after 5 years service. The performance of the air-cooled battery wall was so outstanding that the entire setting was converted to the air-cooled design in 1945

BY N. O. KENNICKER Chief Engineer, Atlas Brewing Co., Chicago

PERFORMANCE has sold the Atlas Brewing Co. on suspended air-cooled construction for their furnace walls, and performance alone. When the boiler furnaces were converted to oil in 1939 and 1940, the solid walls were completely relined; the half of the battery wall adjacent to the No. 1 boiler, however, was replaced with air-cooled construction. In 1942 the lining of the No. 2 boiler was again rebuilt, and once more in 1945, it was necessary to replace the refractory lining. In 1944 the lining of the No. 1 boiler had to be replaced. From all indications, it appeared that the linings would have to be replaced about every 3 or 4 years. When the air-cooled half of the battery wall had been examined on each occasion, it was found to be in good condition and needed no repairs, much less replacement. The performance of the battery wall was so outstanding that the entire setting was replaced by suspended air-cooled construction. Cost comparisons revealed that air-cooled walls cost only slightly more than solid walls in the rebuilding. Details of the experience with both types of walls in the setting follow.

Power Plant Equipment

The boiler plant consists of two 600 hp Page-Burton water tube boilers, set in battery. The load varies from 900 to 1500 hp and is carried on one of the Page-Burton boilers. It is the practice to alternate the Page boilers once a month.

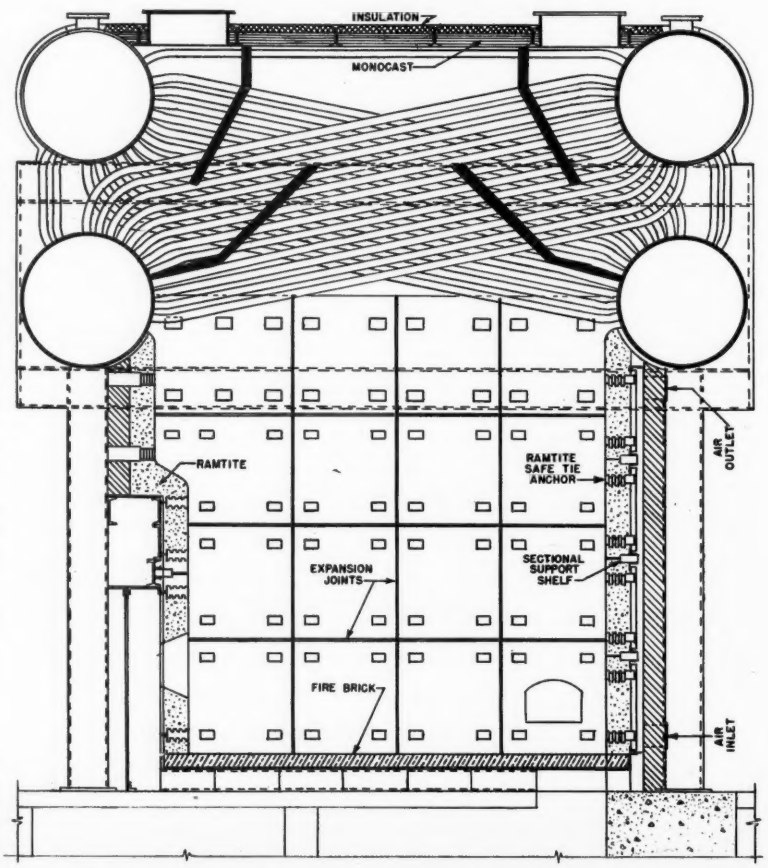


Fig. 1. Section through boiler furnace showing air-cooled side and rear walls

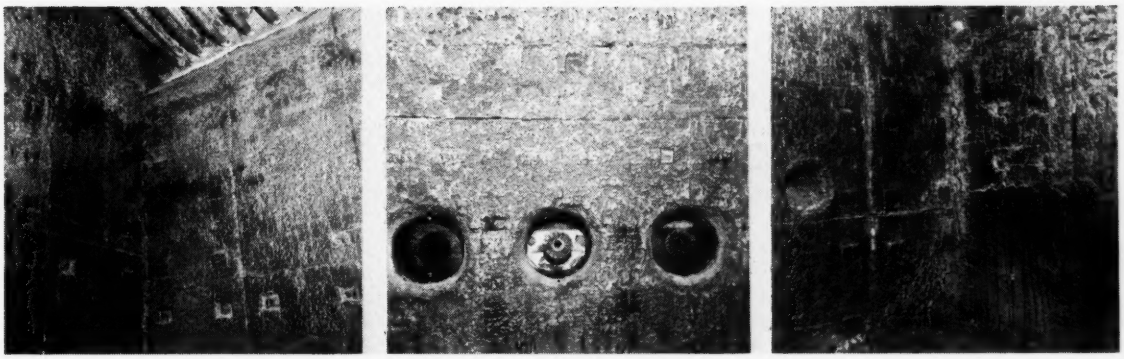


Fig. 2. Condition of the walls of the No. 1 boiler in January, 1948. Left: Upper portions of the rear and side walls. Center: Portion of the front wall surrounding the three Todd burners. Right: Lower portion of the rear and battery walls

The Page-Burton boilers were fired with natural draft chain grate stokers when they were originally installed in 1929. In 1939 the No. 2 boiler was changed from coal firing to oil and later, to combination oil and gas. Three Todd combination oil and gas burners were placed in the front wall and have fired the units ever since; they are of the forced draft type with a fan located in the basement. The air duct is located in the old ash pit so that the air flows through a hollow furnace floor into the burner plenum box. Straight natural gas is used in the summer, when the low rate is in effect, and oil during the winter months. In 1940, the No. 1 boiler was changed from coal to oil and later, to combination oil and gas.

The combustion space of the present furnace is 2180 cu ft. At the maximum load of 1500 hp, the total heat release is 67.5 million Btu per hr at 75 per cent efficiency; this is equal to 30,900 Btu per cu ft per hr. At the lower load of 900 hp, the heat release is 18,600 Btu per cu ft per hr.

When the No. 2 boiler was converted to oil in 1939, the old furnace walls were relined with plastic firebrick against the common brick outer walls. The furnace walls of the No. 1 boiler were relined in the same manner when this boiler was converted to oil in 1940 with the exception that this half of the battery wall was installed as a suspended air cooled wall. This was accomplished by tearing out half of the brick in the battery wall and installing a steel frame from the floor to the horizontal beam in the wall which carries the boiler drums. Cooling air is admitted at the floor line, both front and rear, with air vents at the top.

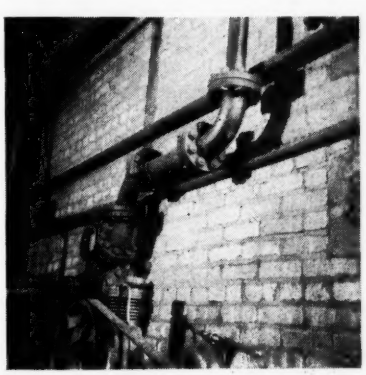


Fig. 3. Looking back toward the rear of the side wall of the No. 1 boiler

In 1942 the lining of the No. 2 boiler was again rebuilt with plastic firebrick against the old common brick walls and once more, in 1945, the refractory lining had to be replaced. In 1944 the lining of the No. 1 boiler had to be replaced after 4 years of service. From all indications it appeared that it was going to be necessary to completely replace the linings of both furnaces as often as every 3 years.

When the lining of the No. 1 boiler was removed in 1944, it was found that the common brick walls, then 15 years old, were in bad shape. It seemed advisable to make a complete replacement up to the tube line. When the air cooled half of the battery wall was examined it was found to be in good condition and needed no repairs, much less replacement.

The success of the air cooled battery wall installation indicated that it would be wise to make the outside walls air cooled also. Comparative bids were obtained for rebuilding the walls using common brick walls lined with plastic firebrick and for the air cooled construction. The latter included a steel supporting frame from the floor to the boiler beam between the boiler columns. A comparison of the bids received revealed that the cost of the air cooled walls was very little more than that of rebuilding the walls solid with common brick construction. It was obvious that it would be more economical to use the air cooled design.

In 1945, when the No. 2 boiler required lining, the walls were changed to air cooled construction, including the other half of the battery wall. When this work was completed, both boiler settings were entirely air cooled up to the boiler beams.

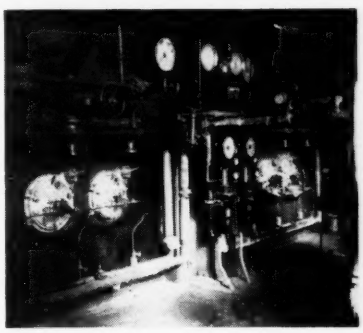


Fig. 4. Front view of the boilers showing the oil burners and instruments

The air cooled wall construction selected was the Ramtite suspended type. In this construction there are expansion joints cut through the plastic every 3 ft, horizontally and vertically, the joints being ship lapped to prevent air infiltration. These vertical and horizontal expansion joints divide the walls into 3 ft square panels. Each panel is supported independently of the others so that when repairs become necessary only the worn portion of the wall need be replaced.

In 1947 an inspection of the No. 1 boiler indicated that it would be advisable to repair the battery wall, then 7 years old. However, it was only necessary to replace the bottom row of panels which represented approximately one quarter of the wall area. At this time one panel in the outside wall and one in the rear wall were also replaced. An inspection of the boiler settings in January 1948, showed the linings to be in good shape and no repairs necessary.

All air-cooled wall installations and repairs were performed by the manufacturer of the plastic firebrick.

PRACTICAL ENGINEER SECTION

Reminiscences of an Old Timer

Back in 1913, when this story takes place, the operating engineer, making $70 a month, was looked upon as a "Favored Citizen." Everything was hunky-dory until the day the river went on a rampage and flooded the power plant with four feet of muddy water. Three weeks were required to clean up and get things back in service again

By **E. R. WEBBER** Chief Engineer, St. Luke's Hospital, Duluth, Minn.

THE SPRING of 1913 found me operating in a small municipally owned Electric Light and Water plant in the middle west. The station was located adjacent to Rock River, a small stream which was little more than a creek. That it could prove to be a powerful and destructive agent, however, will be described fully further on in this article.

Ours was a typical small generating and pumping station. Steam at 125 lbs pressure was generated in three 66 in x 18 ft HRT boilers, which were hand fired. In the engine room were two generating units, one of 135 kva capacity was belted to a 16 in x 42 in simple Corliss engine, while the other, a 65 kva machine was directly connected to a high speed automatic slide valve engine. Both of these machines were exhausted to atmosphere. The smaller unit was used on the day load, the larger machine being brought in for the evening peak. The pumping equipment consisted of two duplex pumps. One was a tandem compound machine utilizing a surface condenser and the other was a plain duplex exhausting to atmosphere. As I remember it, these pumps had about a 15 in bore in the water end with a 16 or 18 in stroke. Water was taken from two surface wells about 30 ft in depth, located adjacent to the plant. The surface condenser, mentioned above, was located on the suction line to the pump so that the cold water from the well acted as a condensing agent. A simplex vacuum pump maintained approximately 18 in of vacuum on the unit which was considered good.

"I had not finished eating my noon meal when the call to help sounded"

We three engineers operating the plant were looked upon as "Favored Citizens." We were drawing $70.00 a month, which was far above what men in other lines of work were getting. We had a steady income twelve months of the year and were inside, where it was warm, in the winter. We, also, had an eight hour shift, while nearly everyone else was forced to work ten hours a day. Even the fact that we worked seven days a week did not detract from our prestige. The oldest man on the job was considered the Chief Engineer and held the 12 noon to 8 p.m. shift. The second man had the 8 p.m. to 4 a.m. watch and the youngest or third man worked from 4 a.m. until 12 noon. The Superintendent had an office up town and was in charge of distribution of both electricity and water. As I remember it we were a self satisfied lot and got along together very well.

It was the usual thing each spring, when the breakup period arrived, for Rock River to overflow its banks slightly and give the people of the small town something to look at and talk about. We had a syphon installed in the flywheel pit of the Corliss engine to remove what ever seepage there was during this period. It was, therefore, with no unusual amount of trepidation that we faced the high water situation this particular spring. The river had been out of its banks for two or three days, but had held to the same depth quite consistently; therefore, had caused us no trouble whatsoever.

Three Long Blasts on the Whistle

On this particular morning, at about 10 a.m., I received a call from the telephone office to the effect that the river was on a rampage about twelve miles north of us and that we should get prepared for a disastrous flood. I attempted to call the superintendent but could not locate him so there wasn't much I could do. I informed the Chief Engineer, when he relieved me at noon, but he did not get all excited about it.

So I went home as usual. We had an arrangement whereby if an engineer on shift got into trouble and needed help badly he would blow three long blasts on the whistle. I had not finished eating my noon meal when the help call sounded and I hurried to the plant. Upon coming within sight of the bridge I could hardly believe my eyes, the whole country side was a roaring mass of water. The level of the water was at least three or four feet over the floor of the bridge and debris of all kinds was piling on and against the latter structure. The plant was in the center of the deluge and appeared to be half submerged. I will always remember the white smoke and steam issuing from the smoke stack. The Superintendent and the lineman arrived about this time, but we were helpless as there was no way of reaching the plant.

Finally someone came along with a boat and the four of us, the night engineer having put in an appearance, made our way through the floating debris to the plant. It was a sorry sight to say the least. The plant was shut down completely, of course, the silence being broken only by two weird sounds, steam issuing from a leaking gate valve stem located on top of the boilers and the gurgling of the water as it entered through the doors and windows on the north side of the plant and flowed through like openings on the south side of the building.

Oil cans, waste receptacles, anything else that could float, was moving aimlessly around the equipment. The Chief Engineer was wading around trying to rescue floating objects before they disappeared through the windows. The belted exciters were completely submerged, as was the smaller city water pump. The fires under the boiler had been completely extinguished and the top guide of the Corliss engine was just discernible above the swirling water. There was not much that we could do at that time but try to straighten up over turned objects and salvage what we could. The peculiar part of the whole thing was that the water began dropping within thirty or forty minutes after we arrived at the plant and by six o'clock that evening was nearly back to normal. However, the condition of the plant was anything but normal. Approximately two inches of sand and mud covered everything after the water receded so our work began.

After a consultation it was decided that the second engineer and myself should operate the plant on a twelve hour shift basis leaving the Chief Engineer free to be on the day shift and assist with the work of getting the generating equipment back into service again. A boiler was fired up and the city water pump put into operation for fire protection for the town. Notices were printed and distributed advising people of the town

"The four of us made our way through the floating debris to the plant"

not to use the city water for drinking until after it had been boiled. The surface wells were filled to the tops with this muddy river water and silt.

Flood Damage

The exciters were taken up town and dried out in an oven but this was, of course, impossible with the alternators. Tents were built over the latter machines and oil heaters used as a drying medium. Every morning these machines were tested for ground and given another twenty-four hour drying period. It was, indeed, surprising to find the engine cylinders half full of sand when they were opened up. This deposit had evidently entered the cylinders through the packing glands even though the latter were steam tight. The bearings were all removed and cleaned thoroughly, sand being found in each one of them. The main belt on the Corliss engine drive was in a terrible shape as practically every lap that had been submerged loosened up and had to be cleaned, scraped and reglued. The same was true of the two exciter belts.

It was noticed after three or four days that longer pumping periods were required to maintain the city water level in the uptown reservoir. The water cylinders on the pump were opened up and it was found that the sand in the water had grooved the brass liners severely. After that it was found necessary to repack the water pistons every two or three days. Later on these liners were replaced. During this period only the simple duplex pump was used leaving the other unit in first class shape after it had been cleaned and reconditioned.

Plant Moved to Higher Ground

As would be expected, the town people were not at all pleased with the lack of electric service. The average person, of course, could not understand what was meant by grounded generators and I am sure we are suspected in many quarters of deliberately stalling but they all lived through the ordeal and on the morning of the twenty-first day after the flood, the large generator rang free of ground and as soon as possible it was put into service. Two days later the small alternator was found clear and was returned to service to the joy of everyone concerned. In a matter of days the episode of the flash flood was forgotten by the majority of the people but not by the city council. This group of citizens determined not to let this thing happen again and, accordingly, plans were made to build a new plant across the river on higher ground. This was accomplished and in the summer and fall of 1915 we moved the equipment piece by piece from the old plant to the new one and with this moving went the possibility of a flash flood ever interrupting the electric service in this little town again.

Of the engineers connected with this episode, I am the only one remaining the others having gone to their reward. This generating station is now equipped with Diesel units, the old steam equipment has been junked. However, fond memories assail me whenever I have occasion to pass by the site of the old plant.

PRACTICAL ENGINEER SECTION

What Caused This Steam Line Stoppage?

Here is an experience with scale deposit that is interesting because of its peculiarities. No apparent scale deposit had existed in the piping system until the call to switch from gas to oil firing came and there was no steam. Investigation revealed a scale deposit that completely closed the steam line. It was about one inch long; on each side of the stoppage the pipe was entirely clean, as was the rest of the piping

By R. O. BARNHART

THE INSTITUTION, where I am employed as an engineer, operates under what is known as the Surplus Gas Contract. This contract permits us to burn gas most of the year at a lower rate than the regular rate. To qualify for this rate it is necessary to have fuel available for standby service which can be put into operation upon notification from the gas company, and within the time specified. (The last notification allowed us one hour for the change over.)

We use oil fuel for standby; it is burned in a steam atomizing flat flame burner. The oil is piped through a ½ in. line which is enclosed in a 1¼ in. steam line, dropping from the top of the boiler, to maintain a fairly constant oil temperature at the burner. Both of our HRT boilers have this arrangement. The entire change over can be made by disconnecting a 1½ in. union on the gas burner and replacing it with the oil burner; connecting two ½ in. unions to the permanent connections. We have started the pumps, and made the change over in 5 minutes flat, with this arrangement.

For about 4 years the call to use oil always found us operating the No. 1 boiler. Although the connections of the No. 2 boiler were unused during this period, they were still under steam pressure to the valve at the burner connections.

The first time the call to use oil found us operating the No. 2 boiler, we discovered there was no steam when we tried to light the oil burner. Our first thought was that the 1¼ in. steam pipe had filled with rust around the ½ in. oil line. To beat the deadline, we rushed temporary connections to the No. 1 boiler and got the oil burner into operation.

Our first conclusion was that our auxiliary heater was not such a good idea and that we should tear it out. We disconnected the ¾ in. union, shown in the center of Fig. 1, when something told me to try the valve at the left, before going any farther. While I could see nothing in that simple piping to warrant any trouble, I tried the valve and no steam showed. So instead of tearing out

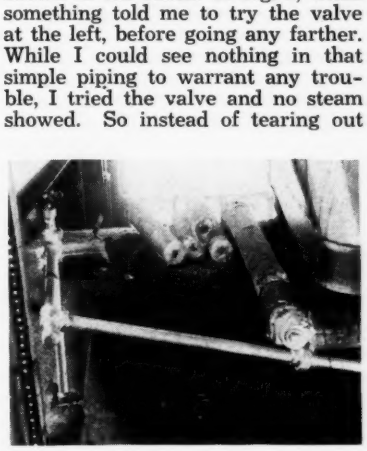


Fig. 1. Angle valve and ¾ in. line in which stoppage was found. The 2 in. auxiliary steam line is shown can be seen at the left. The arrow points to the spot where scale deposit was found

Fig. 2. Pipe sawn through at the edge of stoppage; it completely closed pipe

our auxiliary heater, we took out the pipe to the ¾ in. angle valve; about 5 in. from the valve we found the stoppage. Figure 2 shows the pipe sawn through at the edge of the stoppage. The pipe was completely filled for about 1 in.; *on each side of the stoppage, the pipe was entirely clean, as was the rest of the piping.*

So far no one has been able to figure out why that particular point in the pipe was attacked, or what caused it. Due to the pitch of the pipe, this point would be about the level to which the condensate could rise, but the stoppage would be at almost right angles to the water level. The length of the stoppage was far less than the length of the water level in the pipe at that pitch.

The 2-in. auxiliary steam line is connected between the header valves and the boiler to provide steam for the boiler feed pumps, the oil pumps and oil burners; it has a pitch of better than 1-in. in 10 ft in the direction of the flow. Steam for the burner connection rises about 18 in. vertically from this 2-in. line to the ¾ in. angle valve. From the angle valve it has a pitch of about 1 in. in 10 ft to the tee, from which it pitches sharply to the 1¼ in. pipe that enclosed the ½ in. oil line. The point of stoppage was about 2 ft above the water column and the steam connection was about 8 ft from where the auxiliary steam line connects to the boiler piping.

No Scale for 5 Years

There has been no scale deposit in the boilers since they were cleaned in December, 1941. The feedwater is about 80 percent returns; makeup water comes from Zeolite softeners, at about zero hardness by our soap test. Concentrations are held fairly constant by continuous blowdown through a heat exchanger, combined with a good morning blowdown by hand before lighting the fires.

The boilers operate from 12 to 16 hours a day, depending upon the heating night. They are shut down every night. During the early morning the boilers are operated well above their 150 hp rating, but as the buildings warm up, the heating load drops off. During most of the day they are operating at about 75 percent of capacity, or less. We have always been able to hold the steam pressure with only one boiler in operation at a time.

LETTERS AND COMMENTS

WHICH DIRECTION DOES THE CURRENT FLOW?

IN THE FEBRUARY issue of POWER GENERATION, in answer to Question 393, it is stated (with reference to copper oxide rectifiers) that the current flows from the copper to the oxide. Then further on it states that the resistance of the copper oxide junction is low from the direction of oxide to copper, and high in the direction of copper to oxide. This latter being the case, it is natural to assume that the current would follow the path of least resistance, i.e., from oxide to copper.

Is my conception of the characteristics of joined surfaces in error; or is the theory not clearly expressed in the article?

Pawling, N. Y. SAM WILLIAMS

Editor's Comment: Your confusion is readily understandable. Offhand, the two statements regarding the direction of current through the copper-oxide rectifier seem to contradict each other. Yet if you consider them carefully, you will find that they can be reconciled. The confusion arises as a consequence of a difference in our conception of current flow according to the electron theory and that of the old established convention formulated in the early years of the electrical art.

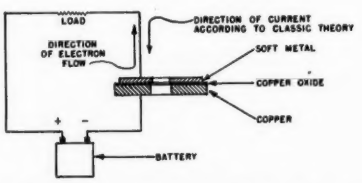
The old established convention represented the current in an electric circuit as flowing from the positive to the negative terminal. This from the standpoint of the electron theory is wrong. The pioneer electrical experimenters, having no knowledge of the electron and, therefore, having no real understanding in regard to the nature of an electric current, arbitrarily assumed the direction of current to be from the positive to the negative terminal. They had a 50-50 chance of being correct. As subsequently disclosed by the electron theory, they chose wrongly but the convention exists to this day.

With this explanation I believe you will understand why the two statements in the answer to Question No. 393 seemed ambiguous. One, the first one which reads "permitting the electrons to flow more readily from copper to oxide," interprets the direction of flow according to the electron theory. The second statement which reads "the junction offers a high resistance to the flow of current from copper to oxide," implies the use of the conventional conception of current flow.

To recapitulate, in the copper-oxide rectifier electrons flow freely in the direction from copper to oxide but the resistance to flow in the other direction is very high. This corresponds to a flow of current in the conventional direction from oxide to copper many times that in the reverse direction.

It is unfortunate that this confusion in conception exists. It never will be removed until we change our conception in regard to the direction of current flow to conform to the electron theory.

I have drawn a diagram which explains this difference in conception perhaps somewhat more clearly than



I have been able to do in the foregoing paragraphs. This diagram, as you will note, shows a cross-section of a copper-oxide rectifier as connected into a direct current circuit. With the negative pole of the battery connected to the copper and the positive pole connected to the oxide, the electrons flow from negative to positive, that is from copper to oxide. However, if you look at this circuit from the convention standpoint since the positive terminal is connected to the oxide, we would ordinarily say that the current flows from positive to negative. —AWK.

WHAT TO DO IF THE WATER LEVEL IS DOUBTFUL?

D. E. Carroll Disagrees, in part, With Persinger and Browning

I WISH TO ACCEPT Mr. Browning's invitation to present my views on what to do in the event that the water level in a boiler is doubtful. In the March issue of POWER GENERATION, Mr. Persinger and Mr. Browning have stated their methods of handling such a situation. I disagree in part with both of these gentlemen.

We three agree that the fuel supply should be stopped immediately. Mr. Browning says not to change the rate of feed nor the steam out-

put. The rate of feed had to be insufficient or the low water condition would not have occurred. If the feed valve remains unchanged and the steam stop opened, it is reasonable to say that the water level will continue to recede. The tube ends and drum, if exposed, would remain unprotected, so that the tubes would be overheated, bulged and possibly ruptured. The longer these portions of the boiler are left exposed, the more damage will be done.

Mr. Persinger states that the feed valve should be closed to prevent thermal shock to the drum. Let me ask: what has been going on as the low water condition developed? The feedwater has been entering the drum, so why not increase the feedwater and bring the level up to normal again? Mr. Persinger would also close the steam stop to retain the pressure and what water is left in the boiler. To close the steam stop would cause the pressure to build up and the safety valves would blow; this would shock the boiler and water would be lost.

The types of boilers so far discussed are water tube boilers with a great deal of refractory, which is all heated to temperatures in the vicinity of 2500 to 3000 F. With temperatures as high as these, any portion of the boiler left unprotected for very long will become overheated and weakened, and often bulged and burned. In both cases described by Mr. Browning and Mr. Persinger, a very serious condition would exist.

The feed valve should be opened slowly and the water level brought up to normal. This is done to cool the exposed portions of the boiler and protect these areas from further damage by overheating. The exceptions to the rule are cast iron boilers, and boilers with cast iron headers. The steam stop should be left open, but steam consumption reduced so that the pressure will not be lowered so fast that the water level cannot be brought up to normal. If the boiler is in battery and is fitted with a non-return valve this valve will close automatically when the boiler has cooled enough to cease generating steam at operating pressure. The steam stops should be closed, on boilers not equipped with non-return valves, when the boiler ceases to generate steam at line pressure.

As stated by Mr. Browning, the type of boiler has an influence on the procedure, but not as much as the individual conditions existing at the time of the difficulty. If the boiler-room is filling with steam the operator is not going to admit more water. No set rule can be made and followed religiously but in general, if water is being admitted to the boiler and excessive leakage is not evident, raise the water level to normal by slowly opening the feed valve.

In the case of a fire tube boiler, or boilers with crown sheets, the same procedure may be followed, if the crown sheet or shell of the boiler is not overheated to the point of bagging. If the boiler is bulged my strongest impulse would be to run, because it is doubtful as to what moment the boiler may blow up. In cases of this kind the feed valve should be closed.

The idea that boilers blow up because the fireman put water into the boiler has been disproved many times over. Boilers fail when the pressure exceeds that which the plate is capable of withstanding. Therefore, if the plates are not bagged they are strong enough to withstand the pressure, and by admitting water slowly to raise the water level, the plates are cooled and strengthened rather than weakened.

Tests have been made on boilers of the locomotive type to prove or disprove the idea that a crown sheet will rupture if over heated and then water is admitted. A feed line was arranged to discharge directly on to the crown sheet. The boiler was fired up and the water level lowered to a point below the crown sheet. When the crown sheet was red hot the feed line was opened wide, feeding cold water directly on to the hot sheet. Nothing happened. This test was repeated many times, but the boiler didn't fail. The engineers remained behind a barricade during the tests, and operated the boiler by remote control.*

In view of these facts, it is my opinion that the water level should be brought up to normal and kept there until the boiler is cooled. An inspection should then be made to determine the extent of the damage and the method of repair.

Hyde Park, Mass. DYER S. CARROLL

*Tests conducted by Manchester Steam Users Assn., Manchester, Eng.

PRACTICAL ENGINEER SECTION

TRANSFORMER OPERATION AT OVER-VOLTAGE

THE ARTICLE, "Transformer Operation at over-voltage," by C. O. von Dannenberg on page 72 of the February issue has brought forth considerable interesting comment. Obviously, the subject is one of

"He says he has something he thinks will be of interest to the heating engineer!"

Transformer Operation

									Per cent of impressed volts to give full load exciting amps	
	1	2	3	4	5	6	7	8	9	10
Mfr	Kva	Phase	High Voltage Kv	Low Voltage Kv	Exciting Amp 110%Nor.	Exciting Amp 10% Nor.	Ratio 6/5	Exponent for ratio 1.10	Base 100%	Base 110%
A	250	1	45.1	2.4-7.2	2.31	4.21	1.84	6.4	1.802	1.80
B	667	1	46.98	2.5-7.5	1.97	6.35	12.3	12.3	1.44	1.35

considerable importance to the practical electrician.

In discussing some of these comments with the author, Mr. von Dannenberg calls attention to a slight error at the top of page 73, where x is given as 1.75 and then, below, it is given as "or 15 per cent over-voltage."

Checking back:

$50 = x^{7.3}$ or $\log 50 = 7.3 \log x$

and $\log x = \log 50/7.3 = 1.698970/7.3 = 0.232736$

$\log 1.8 = 0.255273$

$\log x = 0.232736$

$\log 1.7 = 0.230449$

$\log x - \log 1.7 = 0.002287$

$\log 1.8 - \log 1.7 = 0.024824$

$0.024824 \overline{)0.00228700}\ 0.92$

00223416

52840

or $x = 1.792$.

So 1.75 is fairly close, indicating 75 per cent overvoltage instead of 15 per cent. Since the discussion was presented merely as an outline to show what happens, the error is not serious but it still is desirable to call attention to it.

Since the publication of the article in the February issue, Mr. von Dannenberg has submitted some additional data regarding overvoltage operation of transformers. This data is contained in the accompanying tabulation. It concerns a comparison of the characteristics of two commercial makes of transformers. The names of the manufacturers cannot be disclosed but it is interesting to note the wide variation between the two units. The overvoltage on Unit A checks very close to the author's original 175 per cent value. The exponent of Unit B, based upon the 110/100 ratio is just about double the value for Unit A but it is close to the 12.43 ratio given in the article. Value of item 8 is calculated from relation;

$$Ix_{110/100} \frac{\text{Exciting amp at 110 \% volts}}{\text{Exciting amp at 110 \% volts}} = (1.10)^x$$

$$x = \frac{\log Ix\ 110/100}{\log 1.10}$$

value of 9 is calculated from relation;

$$\frac{\text{Full load amp}}{\text{Exciting amp at 100\% volts}} = (R_{100}) = (E_{R100})^x \text{ or } \log E_{R100} = \frac{\log R_{100}}{x}$$

value of 10 is calculated from relation;

$$\frac{\text{Full load amp}}{\text{Exciting amp at 110\% volts}} = (R_{110}) = (E_{R110})^x \text{ or } \log E_{R110} = \frac{\log R_{100}}{x}$$

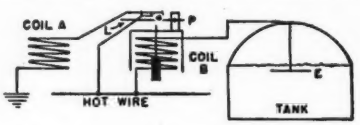
All the above is tabulated from certified test data.

HOW TO KEEP A WATER TANK FROM OVERFLOWING

By ELMER H. HARVEY

THE SCHEMATIC drawing below illustrates a device which we have used to prevent a water tank from overflowing. The tank is located on a hill about one half mile from the plant and well; pumping is done at night during the off-peak period.

Coil "A" is the holding magnet in the motor compensator. Coil "B" is a solenoid with a movable iron core with a brass rod in the top which raises the Lever "L" mounted



on the top of the coil and pivoted at "P." A mercoid tube switch, which is in the holding coil circuit, is mounted on Lever "L." This will stop the pump when Coil "B" is energized and tips up the Lever "L."

Coil "B" is energized when the water in the tank reaches the level of the Electrode E" which is a ¾ in. copper pipe ring 30 in. in diameter. All return circuits are through the ground.

Coil "B" is made of a ⅝ in. fiber tube. It is 2¼ in. long and 2 in. in diameter. It is wound with No. 27 AWG magnet wire, carrying current only when the water is in contact with Electrode "E." The iron core is ½ in. in diameter and 1 in. long. A potential coil, sawed out of an old watthour meter, can also be used as Coil "B."

PRACTICAL ENGINEER SECTION

WIRE LUBRICATION

THERE ARE two ways to lubricate wiring that will run through conduit in order to make it pull easily. Soapstone or paraffin are of about the same value for lubricating purposes. The principal objection to paraffin is the effect heat has on it.

Care should be exercised when pulling the wire through the conduit that too much strain is not exerted as cases have been reported in which the effective diameter of the conductor has been reduced.

Questions And Answers

Question No. 421

WHY DO TRANSFORMER INTERCONNECTIONS WORK THIS WAY?

I HAVE a problem on auto-transformer connections which I can't understand and hope someone can explain. It is an unorthodox connection and one that no data is given on in any engineering books that I have. I will show the connections and the voltage readings I got across them. I might add that I am fairly well informed on the theory of auto-transformer operation when connected in a normal manner.

The tests were made on a small general purpose 0.3 kva 220/440 volt primary to 110/220 volt secondary. With connections as shown in Fig. 1 the voltages are as measured. As can be seen, both windings are connected in series across the line and a higher than line voltage is across the H_1-H_4 part of the winding than the line voltage. Also, it will be noted that the secondary turns are bucking the primary turns. Why doesn't the bucking effect merely reduce the total impedance and make the drop across the high side larger than it would be with the secondary connected not bucking but still less than the impressed voltage?

With the connection shown in Fig.

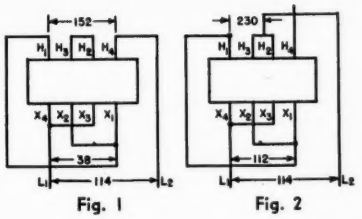


Fig. 1

Fig. 2

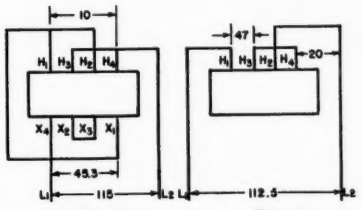


Fig. 3

Fig. 4

1 the ratio of transformation is 4 to 1 or 152 to 38 volts. I thought the regulation would be poor since only 114 volts was being impressed across a 440 volt winding with the sec. in series. I supose this is the same as saying the effective turns across the line is turns high side minus turns of low side. However, where does the transformer action come in? I put a 300 watt load across H_1-H_4 and only dropped the voltage about 20 volts. I made some more tests which I will show in the following diagrams with the voltage readings as shown.

As shown in Fig. 2 a 2 to 1 ratio exists. I would think that the voltage would be 1/3 of line voltage across X_1-X_4 and 2/3 of line voltage across H_1-H_2. It would be if the X_1-X_4 connections were reversed.

In Fig. 3 we have a 1 to 1 ratio. Putting a very small load across X_1-X_4 dropped the voltage to zero. When the same load was put across H_1-H_4, the voltage also went to zero. In fact, the voltmeter itself put enough load on the winding to drop the voltage, because when I put a lower-reading voltmeter having a lower internal resistance, it would indicate no reading. This shows the voltage regulation is now very poor when the ratio becomes or approaches 1 to 1. Why is this? The current flowing through this circuit was 10 amps.

With the high side connected in buck as shown in Fig. 4, the voltages are as measured and putting a small load across either half of the winding dropped the voltage to zero. The current flowing through the winding from the line was 6.1 amps. If both windings form a non-inductive circuit in Fig. 3 and 4, I should think that they would be equivalent to a drop wire and that the ohmic drop, or IR drop, would supply a fairly good load current across a half of the winding. Of course the efficiency would be poor.

I will appreciate any explanation for these results and is this type of connection ever used?

Oakland 2, Calif. R. D. CARRINGTON

Von Dannenberg's Answer

THE COMPLETE REPLY would require a detailed treatise describing the basic theory and operation of the 2-winding transformer and the auto transformer. Assuming the questioner is informed about the general operation the explanations given hereafter may be an aid which supplemented later by additional information as requested, will help clear up some of the present obscurities.

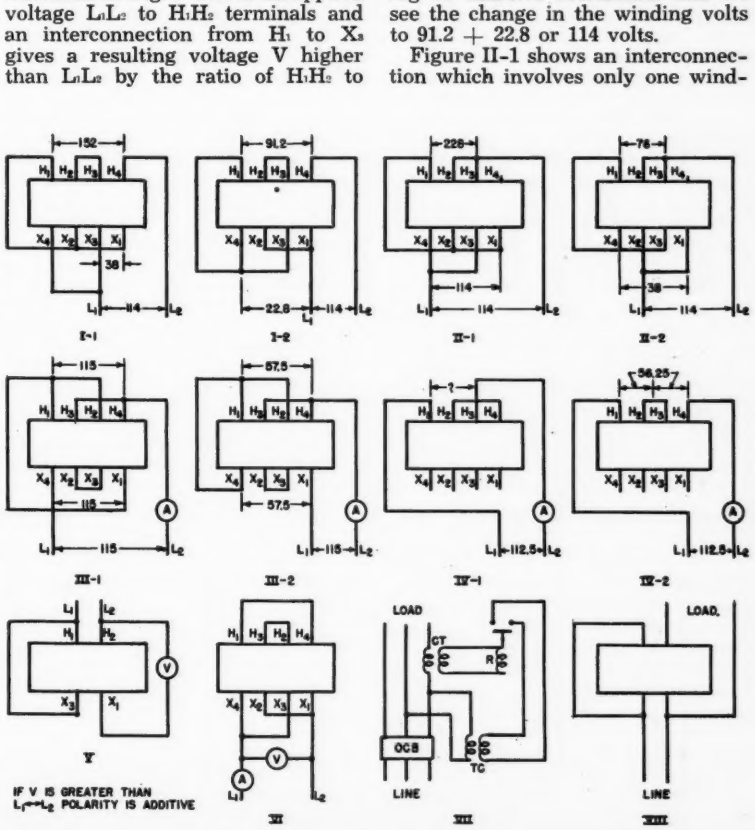
There are, first of all, two definite details to be kept in mind as follows:

1. The applied line voltage L_1-L_2 is always equal to the two winding voltages combined in their proper relation, a direct addition if boosting or the difference of the two if bucking. This is indicated in Figures I-1 and I-2, etc.
2. The separate winding voltages must always have a definite ratio for a certain arrangement of connections and will only change in their actual value, assuming the same line voltage, when changed from a bucking (subtractive) to a boosting (additive) arrangement (interconnection).

All the diagrams indicate a 2-winding transformer with 2 sections per winding and boosting (additive) polarity. This type of polarity is indicated in Fig. 2 where an applied voltage L_1L_2 to H_1H_2 terminals and an interconnection from H_1 to X_3 gives a resulting voltage V higher than L_1L_2 by the ratio of H_1H_2 to X_3X_1 times L_1L_2. Assuming for instance L_1L_2 tube 100 volts and H_1H_2 to X_3X_1 to have a ratio of 4/1 the resulting H_2 X_1 voltage will be 125 volts.

Figure I-1. This is the same as submitted and since the windings are connected 440/110 the ratio is definitely 4/1 as indicated by the voltages measured by test. Since the windings are interconnected bucking (subtractively) one voltage is opposing the other and there must be an automatic adjustment for the two when added together 152-38 to equal 114. Except for experimentation this type of connection has no particular application, but the application of any voltage to a complete circuit causes some current to flow hence creates some magnetic effect which in turn is reflected by induced voltages in the windings proportional to the number of turns. For this application we have the same current flowing through each winding and being connected in one straight circuit like an auto transformer the resulting voltages are in proportion to the ratio or the turns in each winding. Since the two windings are in series the regulation is poor even though a low current flows. As a further comparison Fig. I-2 shows the same arrangement except with X_2X_1 connected to L_1 and X_4X_3 connected to H_1. Here we have a boosting or additive connection and we see the change in the winding volts to 91.2 + 22.8 or 114 volts.

Figure II-1 shows an interconnection which involves only one wind-



Von Dannenbergs Circuits

ing since terminal H_1 is not connected and we thus have a 2/1 ratio and the test shows clearly how we have 228-114 or 114 volts for L_1L_2 and as shown in Fig. II-2 if we put L_1 on X_2X_1 and X_1X_3 to H_1 we get a boosting (additive) action giving 76 + 38 or 114 volts total.

Figure III-1. We have here two practically equal windings bucking each other so the resultant of the two voltages at terminals L_1L_2 will be practically zero, in other words the applied volts L_1L_2 will have no impedance except that of the windings which for a transformer of this type and capacity will be of the order of 10 per cent indicating for an applied voltage of 115 a current of 11.5 amperes which checks well with the tested value. With connections like III-2 we have a boosting arrangement and the voltages would be equally divided with little current flow.

Figure IV-1. This indicates one winding only connected with the other open. Since both sections concerned are wound on a core in close relation and the current in each is in the opposite direction, the effect magnetically would be to decrease the resulting core magnetism. This is indicated by a tested current flow of 6.1 amperes. Indicating an impedance of 112.5/6.1 or 18.4 ohms against 11.5 ohms for Fig. III-1. Should the questioner care to test for the true impedance value Fig. VI indicates the connections. By short circuiting one side and applying sufficient voltage to show full load current in ammeter A, the voltage V_2 is noted; then V_2/ V rating x 100 gives the per cent impedance. The same test can of course be made from the higher voltage side if desired.

Figure IV-2 has reversed connections and is then essentially a choke coil one-half voltage to each section with a very low current flow, just an exciting current which would be of the order of 0.06 amperes or less. It must always be understood that windings like the ones under consideration are never ohmic resistance alone due to their close relation to the magnetic circuit so it would be more accurate to speak of impedance drop or IZ drop, Z being equal to $\sqrt{IR^{-2} + IX^{-2}}$.

The arrangements of Fig. IV-1 and Fig. IV-2 and Figs. III-1 and III-2 can hardly be rated on the basis of efficiency that is output/input but there are always some applications where they may be put to use. A modified form of Fig. IV-2 has long been applied to oil circuit breaker tripping where a-c alone was available. Fig. VII shows such a scheme. Breaker OCB has a potential trip TC wound with two coils one being normally open so the current flow in the other is low; through current transformer CT relay R is operated at a predetermined current value closing the relay contacts which in turn short circuit the idle coil in the trip element and this lowers the impedance through the secondary allowing sufficient current to flow to operate the breaker trip.

As previously explained the scheme shown in Fig. 2 can be used for checking roughly the transformer ratio by using two voltmeters or one meter with suitable switching devices.

The use of interconnection for boosting or bucking the line voltage Fig. VIII is well known but is essentially an emergency application. It is hoped the foregoing may be an aid.

C. O. VON DANNENBERG

Answer No. 413

WHAT METHODS KEEP POWER PLANTS CLEAN?

Elbert Outlines Methods and Principles

CLEANLINESS and safety start with having a place for everything and making sure it is placed there when not in use.

The housekeeping in the boiler house is particularly easy when it is divided among the different watches. Each watch could have a certain section assigned to it and it would be responsible for the section.

Once things are clean, then a painting program could be started so that the boiler house would look like a new place. Boiler fronts could be painted, pumps and pump bases painted, walls could be painted a battleship grey from the floor to 5 ft above the floor and a lighter color from there to the ceiling. This would also make the boiler house brighter.

If there are floor drains, the floor could be hosed down once a week or, if no floor drains, the floor could be mopped once a week. This sounds like carrying housekeeping a little bit too far; but I have worked in plants where the floor was mopped once a week and we were burning soft coal.

Junk or broken parts should never be allowed to accumulate in the boiler house. Cans should be provided for clean waste and rags, also cans for dirty or oily waste or rags.

If it is possible to buy a vacuum cleaning system, this would enable you to keep the boiler tops and lines over the boilers clean. If not, these will have to be brushed once a week.

If the pipes are covered with asbestos, canvassed and sewed, and get two or three coats of paint, they can be hosed down once a week.

Cleaning the boiler house and keeping it clean should not pertain to the operators only. Everyone who comes into the boiler house should be made to understand that it is to be kept clean at all times. Any dirt they make they will have to clean up, so as to leave the place as they found it.

No one should be allowed to throw papers or cigarette butts on the floor or on the boiler tops. It's a hard proposition to try to make the old-timers, who have let things slip for years, understand this; but if you want to keep the place clean you have to keep after them.

It will fall to the chief to make inspections and see that everyone is doing his part to keep the place clean. Some things to look for are cluttered floor, or slippery floor; these should be eliminated. If there are stairs, nothing should be left on them and they should not be slippery. Tools, buckets nor anything else should not be left overhead so they can fall and hurt someone. Fire fighting equipment should be where all can see it and where it can be obtained in an instant. Nothing should be closed so as to make it hard or impossible to get to. Locker rooms and showers should be clean and orderly, no old clothes lying around or piled in the corner. Windows should be cleaned once a month.

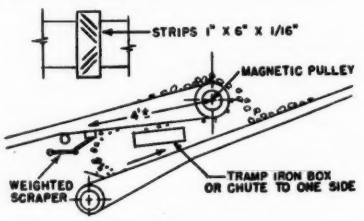
Irvington, N. J. CHARLES H. ELBERT.

Answer No. 418

ROTARY BRUSH KEEPS THIS BELT TOO CLEAN!

IT IS TRUE that the metal fragments adhere to the belt for several feet along the return run, so the belt cleaner must be placed further back than the point where they drop off. A rotary brush is of little use with sticky coal. I suggest that W. G. H. try a cleaner made of short diagonal overlapping strips of stainless steel. That also means that the metal belt

Sketch by W. G. H. in June issue showing how rotary brush and magnetic pulley act with wet, sticky coal



Here's a way to cure the above trouble

clamps must be set-in flush with the belt carcass and covered with a rubber cement compound so the scrapers will not tear the clamps loose. The conveyor must be extended as shown in the sketch.

Akron, Ohio. G. H. W.

Answer No. 419

HOW SHOULD HE INSTALL THIS FUSIBLE PLUG?

L. F. WRITES that he does not get proper service out of the fusible plugs he uses in his hrt boilers. Please do not expect too much of a fusible plug. It is not 100% perfect as a safety device, but it is the best way we have to call attention to low water in an hrt boiler. We suppose that L. F. is carrying only moderate pressure; fusible plugs are not used with 225 psi or higher. The plug may be of wrong design, it may be improperly placed, improperly maintained, may deteriorate in use; any one of these conditions may cause it to blow too soon, too late, or not at all.

We advise L. F. to buy his fusible plugs from a good reputable manufacturer and to have spares on hand all the time. We do not advise L. F. to attempt to refill his fusible plugs himself. We have found cases where a plumber has filled fusible plugs with some kind of solder of which no one can predict the melting point. The Massachusetts Boiler Code says: "All fusible plugs shall consist of a bronze casing, holes in which shall be reamed and tinned before being filled, shall have an even taper from end to end of not less than 5/8 in. to the foot, and shall be filled with 99 percent pure tin." The U. S. Marine Code, among other complete specifications, says that the inside of the casing must show that the tin filling was properly alloyed to the casing. All codes agree that it is poor practice to try to use a fusible plug for too long a time; the laws in most cases require the changing of plugs once a year.

There are two styles of fusible plugs, water-side and fire-side, so named because they are designed to screw into the sheet from either the water or fire side. We once found an engineer who had screwed an inside type plug into the outside of his heating boiler. After a short time it blew out. Any plug should bottom up closely to the sheet on the fire side but stick out at least an inch into the water on the water side, and the taper in the core should lessen in the direction toward which it blows out.

A plug in use may deteriorate because the tin becomes loose in its casing, because the tin expands faster than the casing, the tin filling begins to bulge out of the head on the fire side, and also shows a perceptible bulge on the water side. In fact, if the head of the plug sticks out too far in the flame pass on the fire side, it may lose part of its filling. Next, the core may become loose in the casing, in which case there may be a slight leak around the core. If the leak continues long enough and the water is full of scale, the scale may ultimately replace the outer part of the tin filling and seal it up tight again; the plug may then not blow at all.

I have found several cases where the hole tapped out in the shell was not deep enough to let the plug properly bottom. In this condition the plug stuck out too far into the flame, overheated, and lost part of its filling.

We recommend that L. F. pay close attention to the condition of the fusible plug, at cleaning and inspection time, to detect plugs of the wrong type, defective design, or that stick out into the flame pass too far. He should also detect plugs that leak either around the thread or at the core, plugs in which the core has slipped or bulged at either end, or plugs in which the fire end shows the characteristics of tin oxide, which melts at a considerably higher temperature than metallic tin. The fusible plug should also be kept free from incrustation on both the fire end and water side.

Logansport, Ind. C. C. CUSTER.

Answer No. 420

WHY DOES OIL DISCOLOR IN ONLY ONE NH_3 COMPRESSOR?

IN THE June issue, G. B. showed how his four ammonia compressors in a dairy are connected to a common suction header leading from the liquid accumulation tank. He wanted to know what might be causing the oil to discolor in the last unit on this line. It is a 65-ton unit, the others being two 45-ton and one 10-ton unit.

The oil discoloration occurs only in the 65-ton unit; the other three are all right. The plant chemist has looked at it but can't identify the deposit. It makes the oil look like coffee with cream in it and also has clots in it like sour milk. G. B. has cleaned and drained the compressor three times in less than a week. But each time the oil in this one compressor discolors.

Well, if it looks and acts like milk, maybe it is milk. But how could milk get into only one of the compressors?

If it Acts Like Milk, Maybe it Is Milk, and, says Holman, Here's How it May Get Into the Compressor

G. B. PRESENTS an interesting problem, although he and his chemist seemingly have eliminated water in the oil as the cause of the emulsification. For, if water in the oil were the only cause, the problem would arise in all compressors charged with the oil. Moreover, emulsification would not be stable. Water in a wax-free oil would be driven off by heating, along with the ammonia. The tests run by the chemist point to other contributing factors.

By the conditions set forth by G. B., these factors concentrate at the largest of the four compressors. A study of the drawing shows that the 65-ton compressor differs from the others in:

1. Having much greater capacity.
2. Sitting at the end of the manifold line from the evaporators.
3. Having, possibly, the capacity to pump down the evaporators to a lower suction pressure.
4. There may be a peculiar point of design, such as external lubricator.
5. There may be a leaking jacket, or other fault, such as G. B. is looking for.

G. B. does not describe the external conditions of the evaporators. But if milk or milk products are under pressure greater than that to which the large compressor can pump down the system, inward leakage of such substances might explain the whole phenomenon.

Assuming that milk is flowing over a direct expansion cooler under atmospheric pressure, a smaller compressor may hold the ammonia under, say, 10 psig. Small outward leakage of the ammonia into the product might escape notice. With the larger compressor on the line, however, the pressure in the system may be reduced below atmospheric, and the inward leakage of the product would be carried over into the machine.

If the fault cannot be found at the compressor, I suggest that the above solution be considered.

Decatur, Ill. GEORGE HOLMAN.

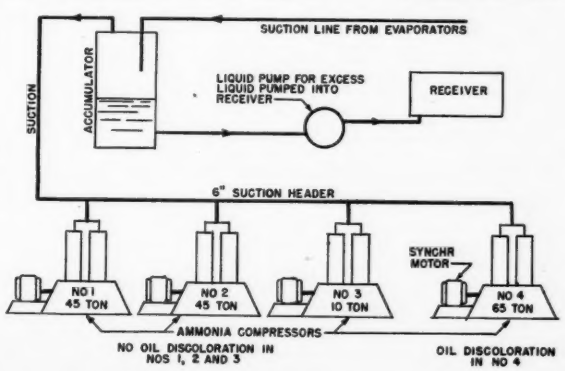


Diagram of G. B.'s compressors showing location of No. 4, the only one in which the oil discolors

PRACTICAL ENGINEER SECTION

MAXIMUM ALLOWABLE CONCENTRATION OF AIR CONTAMINANTS

GASES AND VAPORS

Substance	*M.A.C. (ppm*)*
Acetaldehyde	200
Acetic acids	10
Acetic anhydride	5
Acetone	500
Acrolein	0.5
Acrylonitrile	20
Ammonia	100
Amyl acetate	200
iso-Amyl alcohol	100
Aniline	5
Arsine	0.05
Benzene (benzol)	50
Bromine	1
1,3-Butadiene	1,000
n-Butanol	50
2-Butanone	200
n-Butyl acetate	200
Butyl "cellosolve"	200
Carbon dioxide	5,000
Carbon disulfide	20
Carbon monoxide	100
Carbon tetrachloride	50
"Cellosolve"	200
"Cellosolve" acetate	100
Chlorine	2
2-Chlorobutadiene	25
Chloroform	100
1-Chloro-1-nitropropane	20
Cyclohexane	400
Cyclohexanol	100
Cyclohexanone	100
Cyclohexene	400
Cyclopropane (propene)	400
o-Dichlorobenzene	50
Dichlorodifluoromethane	1,000
1,1-Dichloroethane	100
1,2-Dichloroethane (ethylene dichloride)	75
1,2-Dichloroethylene	200
Dichloroethyl ether	15
Dichloromethane	500
Dichloromonofluormethane	1,000
1,1-Dichloro-1-nitroethane	10
Dichlorotetrafluoroethane	1,000
Dimethylaniline	5
Dimethylsulfate	1
Dioxane	100
Ethyl acetate	400
Ethyl alcohol	1,000
Ethyl benzene	200
Ethyl bromide	200
Ethyl chloride	1,000
Ethylene chlorhydrin	5
Ethylene oxide	100
Ethyl ether	400
Ethyl formate	100
Ethyl silicate	100
Formaldehyde	10
Gasolene	500
Heptane	500
Hexane	500
Hydrogen chloride	10
Hydrogen cyanide	20
Hydrogen fluoride	3
Hydrogen selenide	0.1
Hydrogen sulfide	20
Isophorone	25
Mesityl oxide	50
Methanol	200
Methyl acetate	200
Methyl bromide	20
Methyl butanone	100
Methyl "cellosolve"	25
Methyl "cellosolve" acetate	25
Methyl chloride	100
Methylcyclohexane	500
Methyl cyclohexanol	100
Methyl cyclohexanone	100
Methyl formate	100
Methyliso-butyl ketone	100
Monochlorobenzene	75
Monofluortrichloromethane	1,000
Mononitrotoluene	5
Naphtha (coal tar)	200
Naphtha (petroleum)	500
Nickel carbonyl	1
Nitrobenzene	1
Nitroethane	100
Nitrogen oxides (other than nitrous oxide)	25
Nitroglycerine	0.5
Nitromethane	100
2-Nitropropane	50
Octane	500
Ozone	1
Pentane	1,000
Pentanone (methyl propanone)	200
Phosgene	1
Phosphine	0.05
Phosphorus trichloride	0.5
iso-Propanol	400
Propyl acetate	200
iso-Propyl ether	400
Stibine	0.1
Stoddard solvent	500
Styrene monomer	200
Sulfur chloride	1
Sulfur dioxide	10
1,1,2,2-Tetrachloroethane	5
Tetrachloroethylene	100
Toluene	200
Toluidine	5
Trichloroethylene	150
Turpentine	100
Vinyl chloride (chloroethane)	500
Xylene	200

TOXIC DUSTS, FUMES, AND MISTS

Substance	*Mg/M³**
Antimony	0.1
Arsenic	0.1
Barium	0.5
Cadmium	0.1
Chlorodiphenyl	1
Chromic acid and chromates (as CrO_3)	0.1
Cyanide as CN	5
1,2-Dichloropropane (propylene dichloride) (ppm)	75
Dinitrotoluene	1.5
Fluorides	2.5
Iodine	0.1
Iron oxide fume	15
Lead	0.15
Magnesium oxide fume	15
Manganese	6
Mercury	0.1
Pentachloronaphthalene	0.5
Pentachlorophenol	0.5
Phosphorus (yellow)	0.1
Phosphorus pentachloride	1
Phosphorus pentasulfide	1
Selenium, compounds as selenium	0.1
Sulfuric acid	0.5
Tellurium	0.1
Tetryl	1.5
Trichloronaphthalene	5
Trinitrotoluene	1.5
Zinc oxide fumes	15

MINERAL DUSTS

Substance	*M.P.P.C.F.**
Alundum	50
Asbestos	5
Carborundum	50
Dust (nuisance, no free silica)	50
Mica (below 5% free silica)	50
Portland cement	50
Silica—high (above 50% free SiO_2)	5
Silica—medium (5 to 50% free SiO_2)	20
Silica—low (below 5% free SiO_2)	50
Slate (below 5% free SiO_2)	50
Soapstone (below 5% free SiO_2)	50
Talc	20
Total dust (below 5% free SiO_2)	50

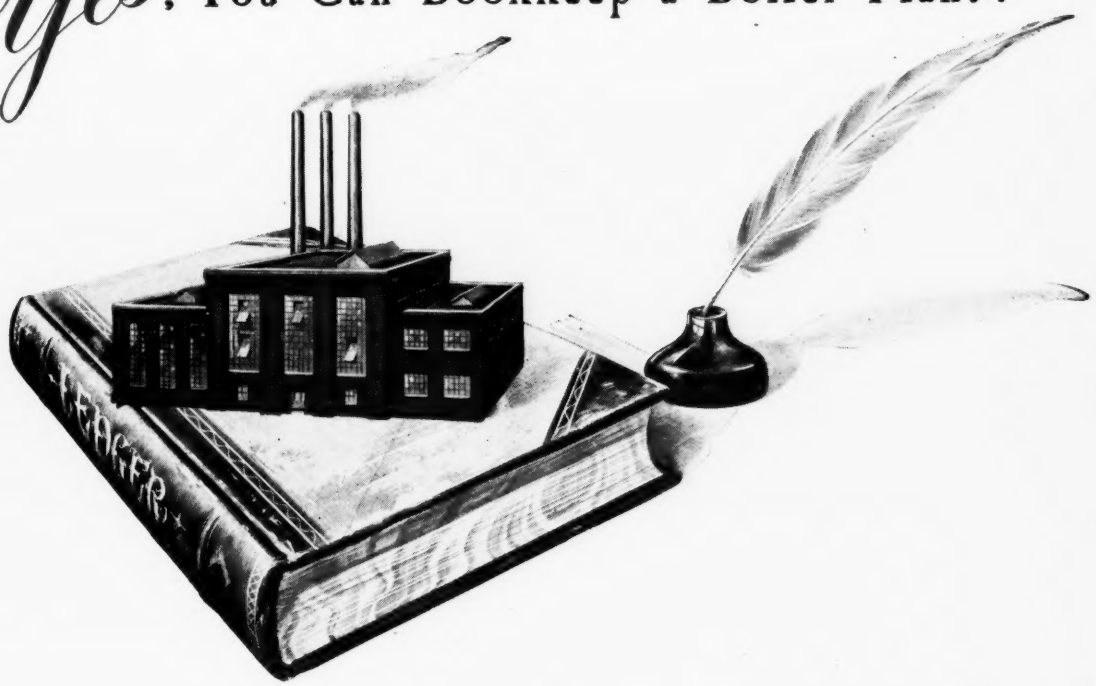
RADIATIONS

Material or radiation	*Radiant energy*
Gamma radiation	0.1 roentgen per day.
Radon	10^{-8} curies per cubic meter.
Thoron	10^{-8} curies per cubic meter.
X-ray	0.1 roentgen per day.

*ppm = parts per million.
*Mg/M³ = milligrams cubic meter.
*M.P.P.C.F. = million particles per cubic foot of air, standard light field count.

Maximum allowable concentration values adopted by the American Conference of Governmental Industrial Hygienists at its 1947 meeting and reproduced from Heating and Ventilating's "Engineering Databook."

Yes, You Can Bookkeep a Boiler Plant!



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Demineralizing Water— and What it Costs

In terms every power engineer can understand and without the complex chemistry, the author explains just how the demineralizing process works . . . How salts are changed to acids in water and how acids are removed . . . Total dissolved solids reduced to minimum, producing equivalent of commercially distilled water or better . . . How silica can be reduced to fraction of part per million by use of fluorides and basic exchange resins . . . Chemical costs for demineralizing water

By **DANIEL J. SAUNDERS,** Vice President, The Permutit Co.

ALL NATURAL WATER supplies are dilute solutions of various mineral substances. These consist mainly of the bicarbonate, sulfate and chloride of calcium, magnesium and sodium. Other mineral substances that may be present are potassium, silica, alumina, iron, manganese, nitrate and spectroscopic traces of other substances.

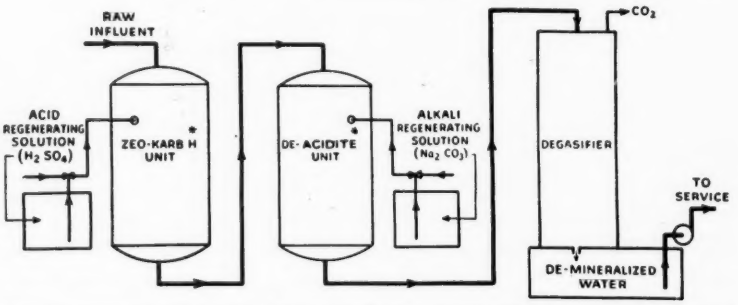
Well-known processes of coagulation, settling, filtration, chlorination, aeration, deaeration are employed to remove other impurities such as turbidity, color, microorganisms and dissolved gasses.

We will presume that the waters to be demineralized are practically clear and colorless when drawn or have been rendered so by pretreatment. The demineralizing process and its costs were discussed in the following manner by the author before the 1947 Annual Meeting of the ASME.

For many industrial uses, the most troublesome mineral constituents are the calcium and magnesium salts which contribute the "hardness" to water. The first methods developed for removing hardness from water were based on treatment with lime and soda. Approximately 40 years ago the zeolite cation exchange process of softening water was invented. By using a sodium zeolite softener it became possible to remove calcium and magnesium ions practically completely from water. The calcium and magnesium ions were exchanged for sodium ions present in the zeolite. The resulting sodium zeolite treated water, however, contains sodium salts equivalent in amount to the chloride, sulfates and bicarbonates present in the influent water. Accordingly, the total dissolved solids of a sodium zeolite treated water is the same as the untreated water.

How Salt Ions Are Exchanged for H Ions

There are cases where the presence of sodium salts in the zeolite treated effluent has been objectionable. In 1936, acid-resistant carbonaceous sulphonated coal zeolites (cation exchangers) were made commercially available. Such organic cation exchangers can be regenerated either with salt brine or with an acid, such as sulfuric or hydrochloric. When influent water is passed through an acid-regenerated zeolite, the sodium, calcium and magnesium ions in the water are removed by the zeolite and exchanged for hydrogen ion. The effluent of the acid regenerated zeolite accordingly contains hydrochloric, sulfuric and carbonic acids in amounts equivalent to the chloride, sulfate and bicarbonate content of the raw water.


RAW INFLUENT
ACID REGENERATING SOLUTION (H_2SO_4)
ZEO-KARB H UNIT*
DE-ACIDITE UNIT*
ALKALI REGENERATING SOLUTION (Na_2CO_3)
DEGASIFIER
CO_2
TO SERVICE
DE-MINERALIZED WATER
STEP NO. 1
REPLACEMENT OF METALLIC CATIONS BY HYDROGEN (H ION) CONVERTS SALTS PRESENT IN RAW WATER INTO CORRESPONDING ACIDS, VIZ. HCl, H_2SO_4, H_2CO_3
STEP NO. 2
REMOVAL OF ACIDS FORMED IN STEP NO. 1. THE HCl AND H_2SO_4 ARE ABSORBED IN THE DE-ACIDITE UNIT AND THE H_2CO_3 DECOMPOSES INTO H_2O AND CO_2, THIS CO_2 ESCAPING TO THE ATMOSPHERE IN THE DEGASIFIER.

*Trade Mark Reg. U. S. Pat. Off.

Fig. 1. Diagram of 2-step process for demineralizing water

The carbonic acid decomposes readily into free carbon dioxide and water and is readily removed by degasification. Hydrochloric and sulfuric acid are neutralized either by feeding an alkali, such as sodium carbonate or caustic soda, or by blending with the effluent water from a sodium zeolite softener in proper proportion. By this process it is possible to reduce the bicarbonate content of the water to any desired value. The sodium content can also be reduced by this process to the equivalent of the chloride and sulfate present in the raw water. Therefore, by this process the lowest point to which total dissolved solids can be reduced is limited by the concentration of chloride and sulfate present in the raw water.

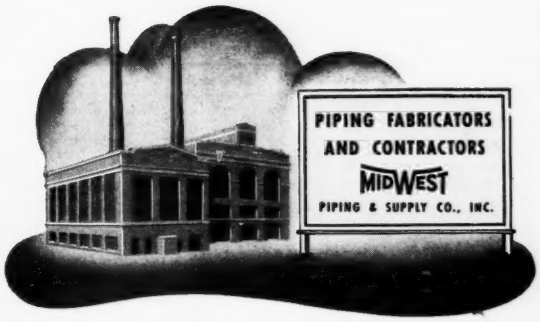
Acid absorbent anion exchangers became commercially available approximately 10 years ago. These exchangers were capable of removing the hydrochloric and sulfuric acid formed in the hydrogen cation exchange process. By removing the hydrochloric and sulfuric acid present in the hydrogen cation exchange effluent, by means of an absorbent anion exchanger, it became possible to produce a water having an electrolyte content equivalent to commercially distilled water. Carbonic acid is not removed by the ordinary anion exchanger, but is removed by degasification.

This demineralizing process is usually a two-step process as shown in Fig. 1. At the bottom of Fig. 1, the chemical action of each of the two steps is described.

How Demineralizing Produces Distilled Water Equivalent

The raw influent water enters the Zeo-Karb H unit (cation exchanger unit in Fig. 1). The water then passes into the De-Acidite unit (acid absorbent anion exchanger unit in Fig. 1). The effluent of the De-Acidite unit is then passed to a degasifier to remove CO_2 and then to service.

When the exchange capacity of the cation exchanger unit (Zeo-Karb H in Fig. 1) has been exhausted, the unit is regenerated by passing a dilute solution of sulfuric acid through the bed. When the De-Acidite unit (acid absorbent anion exchange unit in



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3480

Table I. Quality of influent and demineralized water at several industrial demineralizing plants

ppm as $CaCO_3$	Water A		Water B		Water C		Water D	
	Raw	DM	Raw	DM	Raw	DM	Raw	DM
Total Hardness	43	0	116	0	212	0	302	1
MO Alkalinity	34	3	58	3	140	6	227	4
Sulfates	24	0	88	0	100	1	75	1
Chlorides	6	0	3	0	34	3	35	0
Total Salts	64	3	149	3	274	10	337	5
Regenerating cost per M gal.	$0.03		$0.04		$0.07		$0.07	

Table II. Chemical costs for treating 5 waters of different dissolved solids content

ppm as $CaCO_3$	Water E	Water F	Water G	Water H	Water I
MO Alkalinity	100	200	200	250	250
SO_4	15	100	100	150	250
Cl	10	150	400	600	750
Total Salts	125	450	700	1000	1250
Regenerating cost per M gal.	$0.02	$0.14	$0.34	$0.56	$0.79

Fig. 1) is exhausted, it is regenerated by passing a dilute soda ash solution through the bed. The complete regeneration procedure consists of backwashing, regenerant introduction and rinsing to waste, and generally requires about one hour for each unit. Where desired, it can be carried out automatically. Good equipment design and operation are necessary for economical operating costs.

How Silica is Removed in Demineralizing Process

In the standard two-step demineralizing process described above, silica is not removed by the treatment because silicic acid is a very weakly dissociated acid, and is not absorbed by the usual anion exchanger. Where low dissolved silica is desired in the demineralized water, special methods of treatment must be employed. Silica can be reduced by pretreatment, when such pretreatment is necessary because turbidity and color are present in the raw water supply. The chemical treatment costs for silica removal by such pretreatment methods are relatively low. In such pretreatment methods, silica is absorbed by ferric hydroxide floc, or by magnesium hydroxide. However, in such cases the dissolved silica is reduced only to about 1 to 3 ppm, depending on the type of treatment and the conditions maintained during the treatment. Where silica is to be reduced to a very low amount, other methods are employed.

Removing Silica Almost Completely

Two basic methods are available for removing silica almost completely in conjunction with demineralizing water. In one method, a soluble fluoride is fed to the water entering the hydrogen cation exchange unit. On passage through the cation exchange unit, the fluoride is converted to hydrofluoric acid. The hydrofluoric acid reacts very rapidly with the dissolved silica in the water and forms fluosilicic acid. This fluosilicic acid is absorbed by the anion exchanger; and thus the demineralized effluent of the anion exchange unit is also free of silica. Generally sodium fluoride is employed as the source of fluoride ion to be fed to the water to be treated. However, some efforts have been made to employ cheaper fluorides such as insoluble calcium fluoride for this purpose.

The second important basic method for removing silica from water is to pass the hydrogen-zeolite-treated water through a special highly basic anion exchange resin. Since such highly basic resins also absorb stronger acids, such as hydrochloric, sulfuric, and carbonic, it is frequently advantageous to remove these acids before passage into the silica absorber resin unit. Hydrochloric acid can be readily removed from the hydrogen-zeolite-treated water by passage through a conventional anion exchange unit. Carbonic acid can be most economically removed from the water, before the water enters the silica absorber unit, by passage through a standard forced-draft degasifier. By both the fluosilicate and the direct anion exchange methods, it is possible to reduce the silica in the demineralized water to a fraction of a part per million.

In order to select the most suitable process for producing a low total dissolved solids water, it is necessary to make a complete engineering study. It is necessary to decide on the maximum tolerance permissible for the various constituents present in the treated water. The total operating cost for producing this water must include the fixed charge caused by the equipment and installation cost. Fuel, chemical and operating labor costs must also be included.

Chemical Costs to Obtain Low Dissolved Solids

It is possible to compute the chemical cost to demineralize water to a low dissolved solids content as shown in Table I by employing the curves in Fig. 2. The heavy curves are based on purchasing sulfuric acid at $20 per ton and soda ash at $30 per ton. The dotted curves are based on purchasing sulfuric acid and soda ash each at $40 per ton. To determine the chemical cost for demineralizing:

(a) Read across to the number of ppm MO Alkalinity (as $CaCO_3$) in the raw water, then up to the methyl orange alkalinity curve; then read off the cost of chemicals at the side.

(b) Read across to the number of ppm sulfate plus chloride (expressed as $CaCO_3$) in the raw water, then up to the sulfate plus chloride curve; then read off the cost of chemicals at the side.

(c) The chemical cost of demineralizing equals the sum of results obtained in (a) and (b).

Investment and labor costs for demineralizing are generally much lower than for evaporation. From such figures, therefore, one can readily decide in most cases whether or not any detailed consideration should be given to evaporation as compared to demineralizing.

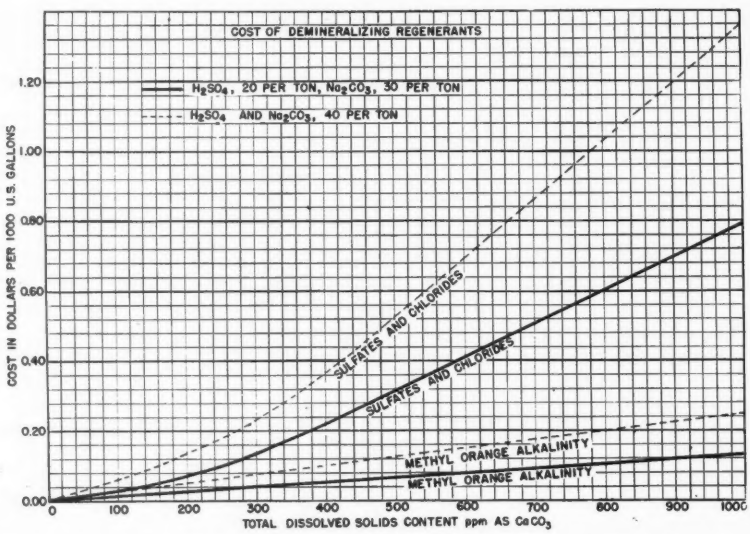

Fig. 2. Curves showing chemical costs of demineralizing water to low dissolved solids contents as shown in Table I

Lower curve: costs of reducing MO alkalinity for two chemical costs. Upper curves: costs of reducing sulphates and chlorides for two chemical costs. Read each separately, then add two costs to get total cost

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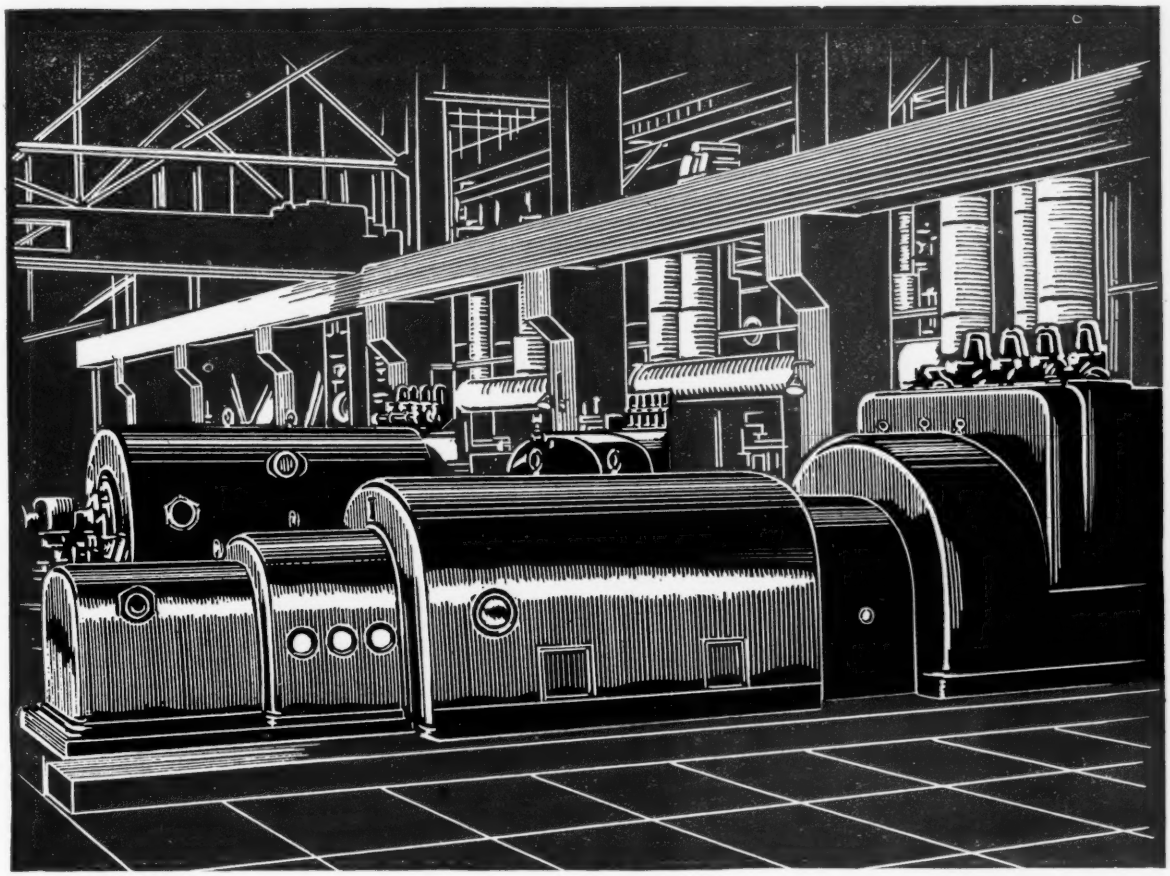

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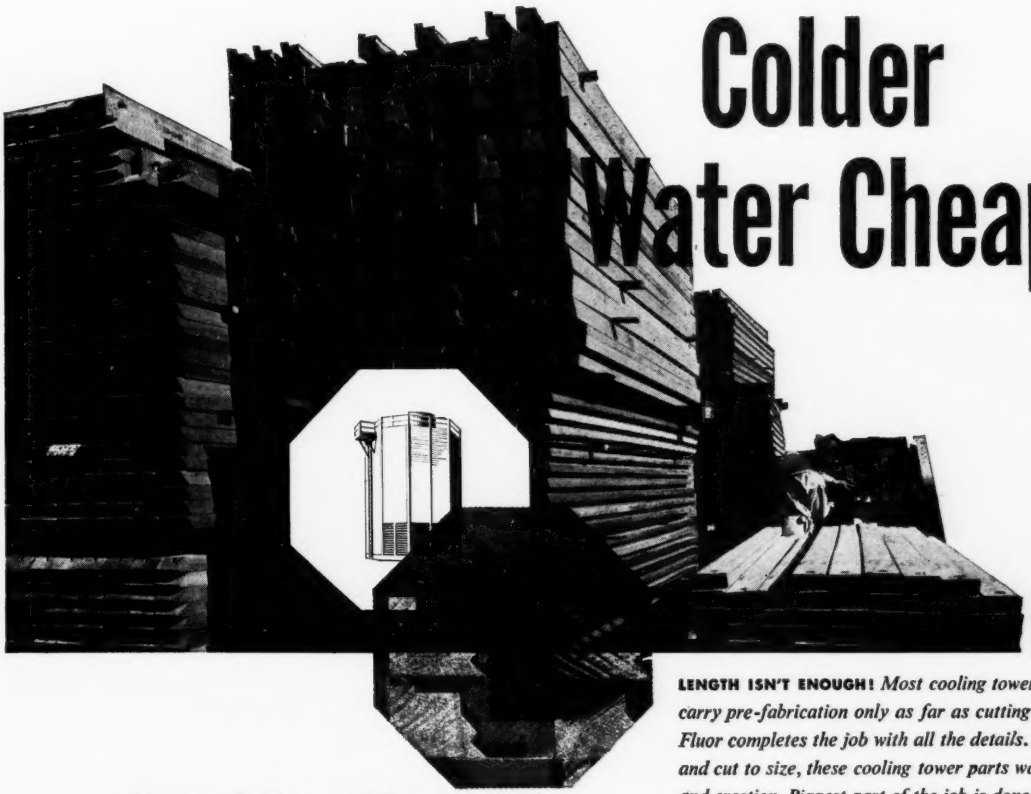

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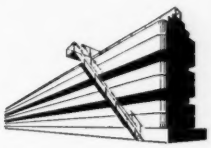

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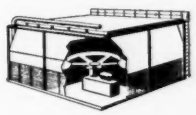

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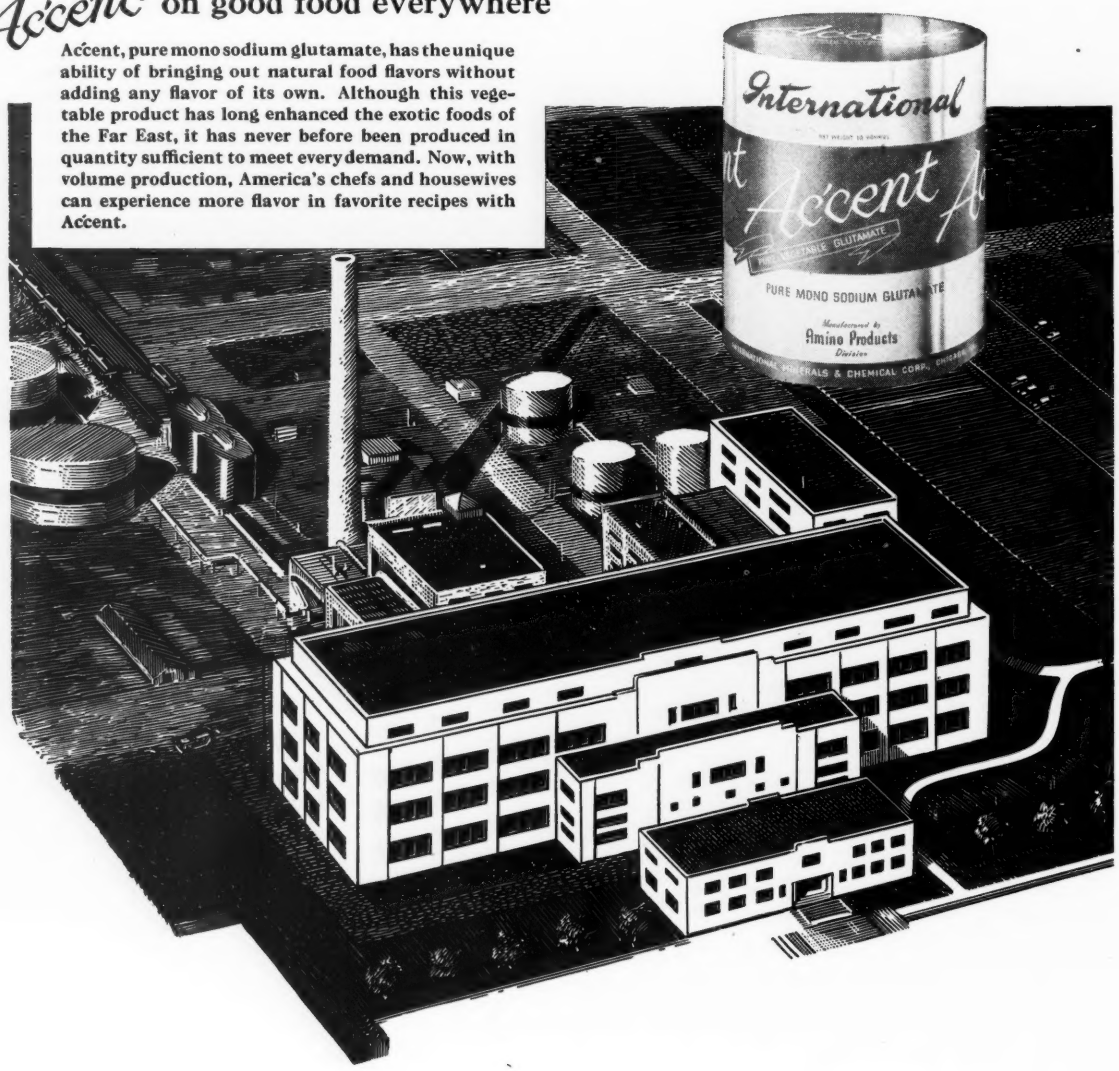

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"When I purify Diesel fuel oil, I enable the operator to get maximum effective usefulness from his fuel oil.

"I'm written up in Bulletin 400 (Turbine Oil) and Bulletin DL-1 (Diesel Oil). Either will be sent on request."

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

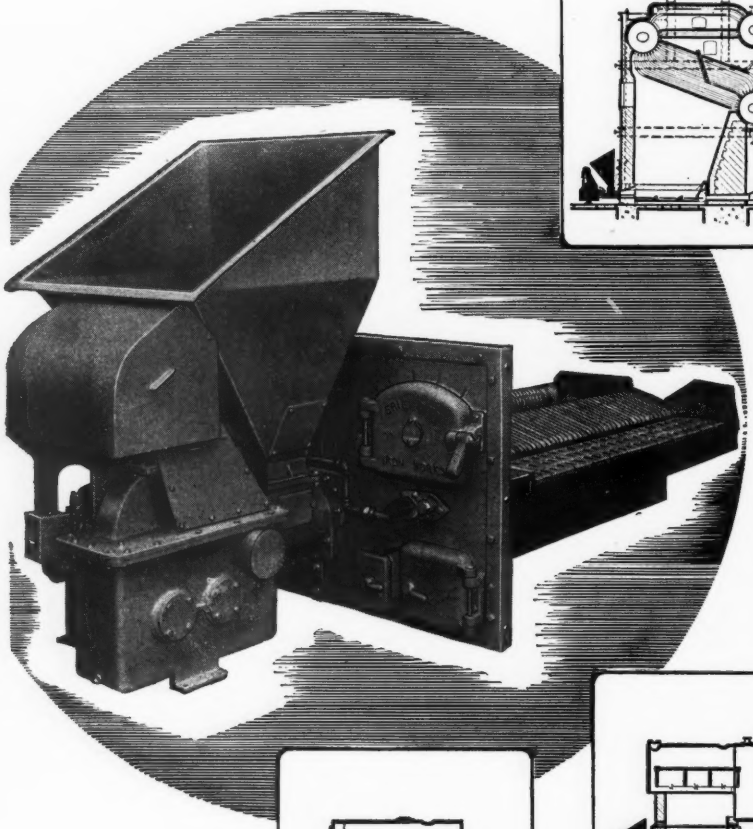
DE LAVAL

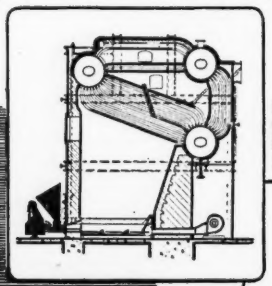
Lubricating Oil Purifiers

ERIE CITY'S NEW STOKER

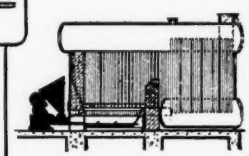
Combines with 5 Erie City Boiler-Furnace Units

The new Erie City Underfeed Stoker, completely built in our foundry and shops, backed by over 100 years of "know how" in boiler firing, was primarily developed to team up with Erie City Boiler-Furnace units. Erie City's new stoker embodies the best features of modern stoker design. A special heat resisting alloy iron was developed in our foundry for all castings exposed to the fire. All parts are of extra heavy design to assure long life and low maintenance. Erie City Stokers are available in two types to meet any single retort Underfeed Stoker firing need, each in a wide range of sizes. Write for catalog.

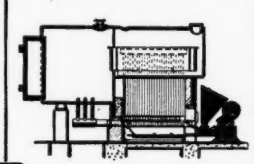




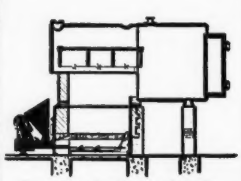
Erie City Underfeed Stoker firing Erie City Type C 3-Drum Boiler



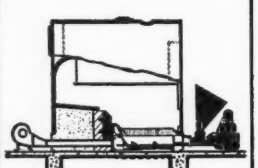
Erie City Underfeed Stoker firing Erie City Type VL Boiler



Erie City Underfeed Stoker firing Erie City Water Wall Economic



Erie City Underfeed Stoker firing Erie City Standard Economic



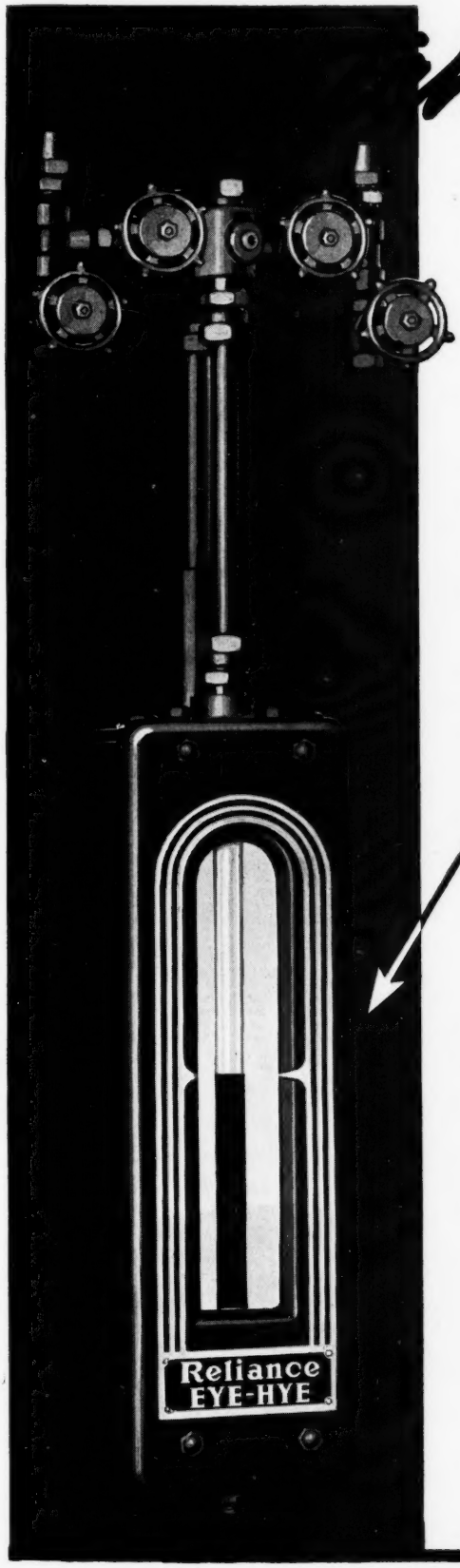
Erie City Underfeed Stoker firing Erie City Heating Boiler

● COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators ● Type C 3-Drum Boilers ● Type VL 2-Drum Boilers ● The "Economic" Boiler with or without Water Walls ● Welded H. R. T. Boilers ● Welded Steel Heating Boilers ● Coal Pulverizers ● Underfeed Stokers ● Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*



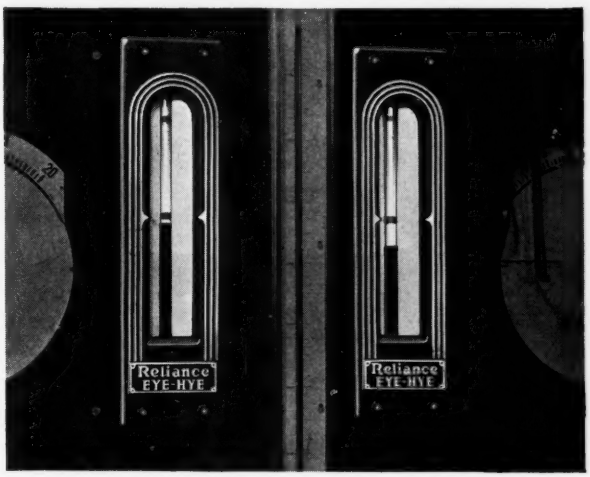
EYE-HYE'S® GREEN FLUID

for *accurate, dependable* reading of your vital boiler water levels

EYE-HYE is a duplicate gage (remote reading) that's usually more accurate than the gage at the drum. It *reads like* the usual gage—carries the same type of image to your instrument panel or to an *eye-level* position near the boiler. Its green indicating fluid is illuminated . . . stands out strikingly clear among other instruments and controls . . . a familiar sight in thousands of power plants.

SIMPLICITY is the secret of EYE-HYE's dependable full-range accuracy—all hydrostatic operation, no mechanical working parts. Factory-calibrated to your water level range and working steam pressure—nothing to adjust during installation; cannot be tampered with. Easy to install, practically no maintenance.

Various EYE-HYE models fit any remote gage need—boilers, tanks, storage vessels—any pressure. More than 8000 EYE-HYEs in use, on land and sea. Write the factory or your nearest Reliance Representative for more details.



BOILER SAFETY DEVICES since 1884

Reliance®

THE RELIANCE GAUGE COLUMN CO. · 5902 CARNEGIE AVENUE · CLEVELAND 3, OHIO

YARWAY
IRON
SCREWED-END STRAINER
FLANGED-END STRAINER
Easy
TO SERVICE
• A good strainer protects your equipment and pipelines.
Maintenance men said "give us a strainer with a blow-off cap that comes out easily and makes up tight; a screen that can be put back in place without a lot of fiddling around".
• The easy-to-remove Yarway cap meets these requirements. It has straight (not tapered) thread, machined face and spark-plug-type gasket. Permits easy removal for cleaning. Insures proper screen alignment when replaced in body.
• Screen itself is of high grade woven monel wire, or perforated if desired.
• Body of strainer is iron or steel, cadmium-plated for protection against corrosion and for better appearance.
• Available in six sizes, ½" to 2", for pressures to 600 lbs. Reasonably priced. Hundreds of thousands in use. Stocked and sold by 150 Mill Supply Houses.
• See your dealer or write for Bulletin S-201.
YARNALL-WARING COMPANY
114 Mermaid Ave. Philadelphia 18, Pa.
YARWAY STRAINERS
"Police the Pipelines"

HELPFUL BULLETINS

(Continued from page 38)

63 **Metal Protective Coating** — This 20 page book presents the protective coating for metals made by this firm with many application photos, coated and uncoated test and application photos, other illustrations show methods of application, such as spraying, brushing, and dipping. Industrial Metal Protectives, Inc.

64 **Industrial Glass Block** — Booklet IB-73, 36 pages, is arranged in ten sections on: Light, Insulation, Heat gain, Permanency, Protection of equipment, Sanitation, Sound reduction, Sizes and patterns, Installation, and Specifications. Application photos, charts, tables, and dimensional drawings are provided. American Structural Products Co.

65 **Suspended Lights and Devices**—Catalog No. 47, 98 pages, is the complete catalog of this maker of disconnecting and lowering fixtures for lights and other devices. Pertinent data for selection of fittings for many uses is given with prices. Most equipment is illustrated and sizes available stated. Thompson Electric Co.

66 **Naphthenate Preservatives**—Bulletin No. 381, 6 page folder, describes the naphthenate preservatives made by this firm and explains their action. Listed are the materials of wood and textiles they may be applied to. Quigley Co., Inc.

67 **Porcelain Tank Linings**—This 8 page folder describes and explains the porcelain lining for tanks with illustrations and list of the claimed advantages. Recommended by the maker for use in tanks containing hot or cold water, and for filter, softener, fire sprinkler, and drinking water tanks. Howe E. Baker Co.

68 **Windows, Doors, and Accessories** —A bulletin of 36 pages describing the steel windows, doors, and the various accessories such as catches, hinges, trolleys, that go to make up units. Drawings and sketches are used to show installation and types for various uses. Sizes are given with dimensional drawings and tables. Wm. Bayley Co.

69 **Rolling Doors**—Bulletin No. 49, 28 pages depicts the many different types of doors and steel rolling grills made by this firm and with application drawings and photos shows the controls and other equipment required for the operation of these doors by hand or by motor. Drawings through sills and jams show the manner in which the door is applied to the building framework. Sizes of doors available for each type are listed with specifications given. Kinnear Mfg. Co.

70 **Roof Protection**—A 28 page roofing book filled with actual before and after photographs on repair and maintenance of roofs. Photos show how to prepare the roof, apply the coating and put on the fabric for the roof in general and for flashing. 15 pages of general instructions and estimates for covering roofs are provided. Roofs of all different types and composition such as roof over concrete, roof over wood, paper or composition. United Laboratories, Inc.

MISCELLANEOUS

71 **Alloy Spring Steels**—This 16 page booklet is an abstract of an engineering paper on this subject. Presented is data on the physical properties of three alloy steels used for hot-formed springs, together with properties of plain carbon steel spring for comparison. International Nickel Co., Inc.

72 **Liquid Filters**—Bulletin D-IL, 8 pages, describes the liquid filters with text, photos, cutaway drawings, exploded views, phantom views, and tables. Dollinger Corp.

73 **Chemical Fire Extinglishers** — Bulletin No. 4845—A 16 page bulletin that shows with sketches and photographs how to handle, load, discharge these extinguishers. 5 different sizes of extinguishers are listed. These are all of the dry chemical type. Specifications as to capacity, weight, test pressure are given. Fan and straight stream type nozzles to be used with these extinguishers are given. A table of characteristics of approved hand fire extinguishers to be used on various types of fires is provided. The charts show comparative effectiveness of approved fire extinguishers on various types of fires. Ansul Chemical Company.

Battery of boilers in public service plant using Dearborn Water Treatment and Engineering Service.

. . . BOILER WATER TREATMENT

would be a simple mechanical operation

But boiler water treatment cannot be standardized on a push-button basis. It is accomplished scientifically, and that calls for the assistance of water experts . . . right at your elbow.

Dearborn is an organization of chemists, laboratory technicians, and water experts. Dearborn Water Treatment and Engineering Service provides means for avoiding difficulties in your plant which may be caused by water supply characteristics or variations.

Dearborn
TRADE MARK REGISTERED

THE *Leader* FOR OVER 60 YEARS

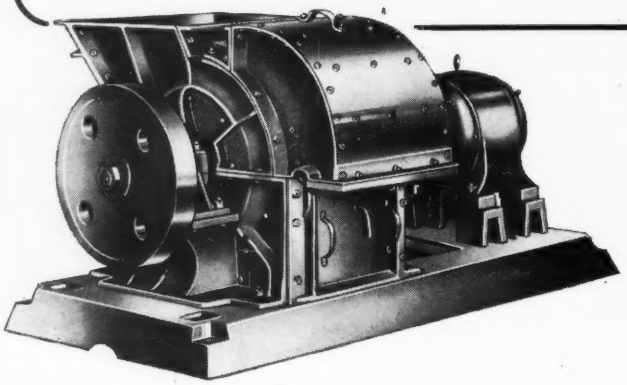
ENGINEERING SERVICE AND WATER TREATMENT

DEARBORN CHEMICAL COMPANY
310 S. Michigan Ave., Chicago 4 807-15 Mateo St., Los Angeles
205 E. 42nd St., New York 2454 Dundas St., West, Toronto

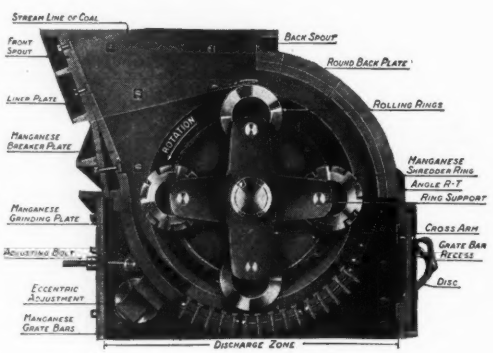
Increase firing efficiency . . . . through better coal preparation

with

AMERICAN ROLLING RING CRUSHERS



American Type "S" Crusher with housing of massive cast steel construction—rib reinforced to withstand enormous crushing strains. Dust-tight machined joints. Self-aligning anti-friction bearings in dust-tight pillow blocks.



Designed especially for power plants, heavy-duty American Type "S" Rolling Ring Crushers are providing high output, uniform coal reduction at minimum cost in plants throughout the country. By reducing coal to uniform size with exacting control of fines and no oversize, Americans have actually *increased* firing efficiency from 2½ to 8% over coal prepared in conventional crushers! These amazing results are proof of the ability of Americans to help power plants get greater production efficiency, more BTU's out of every pound of coal.

The key to the greater efficiency of American Crushers is the manganese shredder rings—found only in Americans. Shown in the cross-section at left, these rings split coal at low speeds instead of crushing it at high, power-wasting speeds. By revolving on individual shafts, each ring is free to deflect without damage from tramp iron—eliminating the need for safety devices or shear pins.

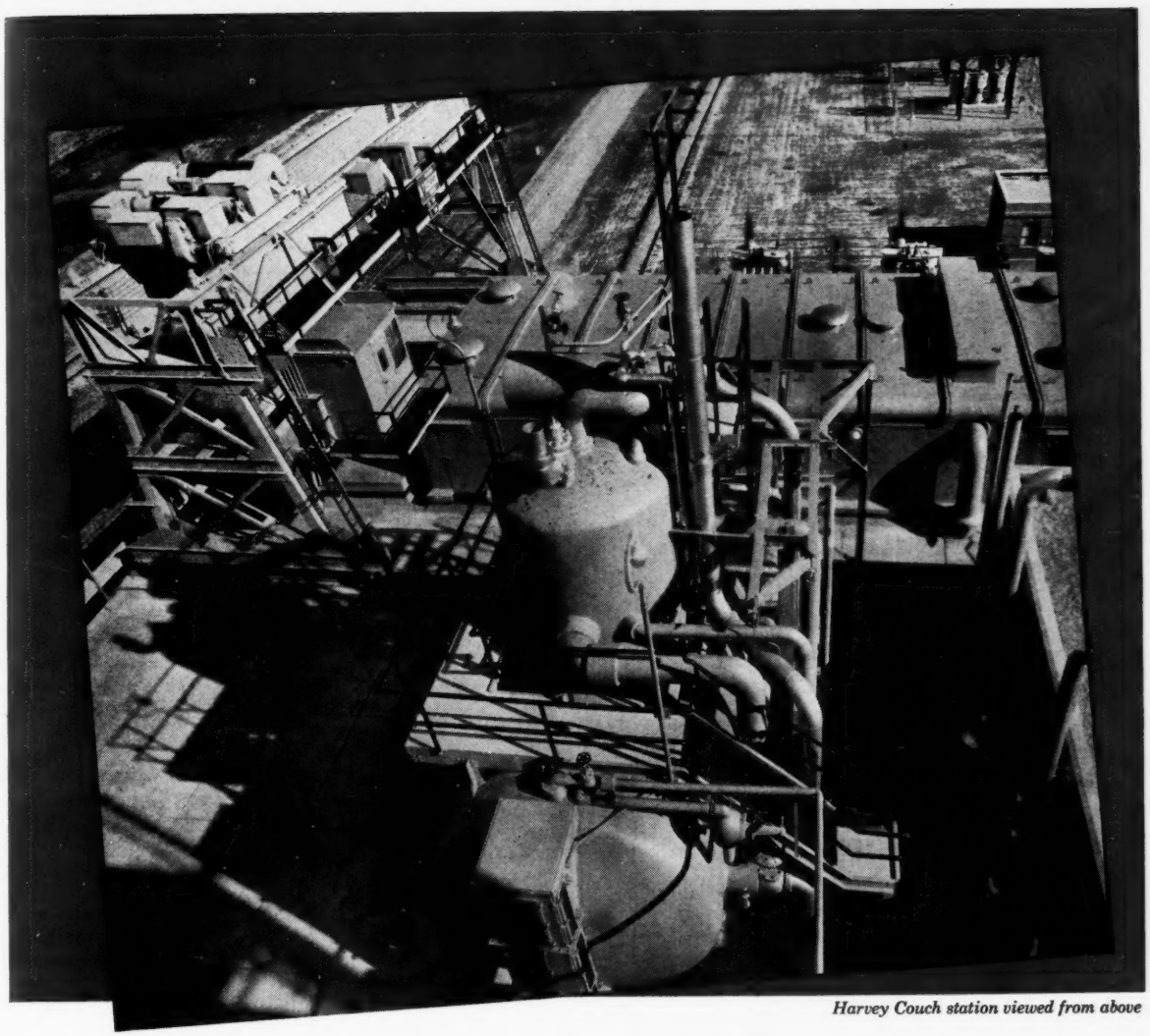
American Type "S" Crushers are custom-built to give guaranteed high efficiency performance for every reduction job. They offer a complete crushing plant in one compact unit, no auxiliary crushers or refuse picking operations required. Available in nine sizes — capacities from 25 to 500 TPH.

Send for bulletin: "Crushing Coal for Less Than 1c a Ton"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 Macklind Avenue
St. Louis 10, Mo.



Harvey Couch station viewed from above

The pipe lines had to be strong

PIPE lines in Arkansas Power & Light Company's 30,000 KW Harvey Couch station have to be able to take it — *plenty!* Steam lines were designed for 710 pounds pressure at 830° F.; boiler feed lines for 1,000 pounds pressure at 350° F.

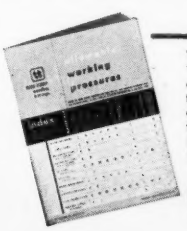
It's a natural for welding fittings, and Tube-Turn seamless welding fittings always fill the bill.

Made by a special forging process, Tube-Turn welding fittings strengthen piping systems at points of greatest stress. They form a continuous metal structure with the pipe. Their leak-proof, welded joints are strong as the pipe itself. Their smooth inner walls and easy, sweeping radius facilitate flow, reduce pressure loss and erosion. Once installed, they rarely require attention. They're easily installed.

Tube-Turn welding fittings are manufactured in a wide range of types, sizes, metals and alloys. Your nearby Tube-Turns distributor carries a large stock. For fast service in good connections, specify "Tube-Turn."

TUBE TURNS, INC.
234 E. Broadway, Louisville 1, Ky.

District Offices at New York, Philadelphia, Pittsburgh, Detroit, Chicago, Houston, Tulsa, San Francisco, Los Angeles

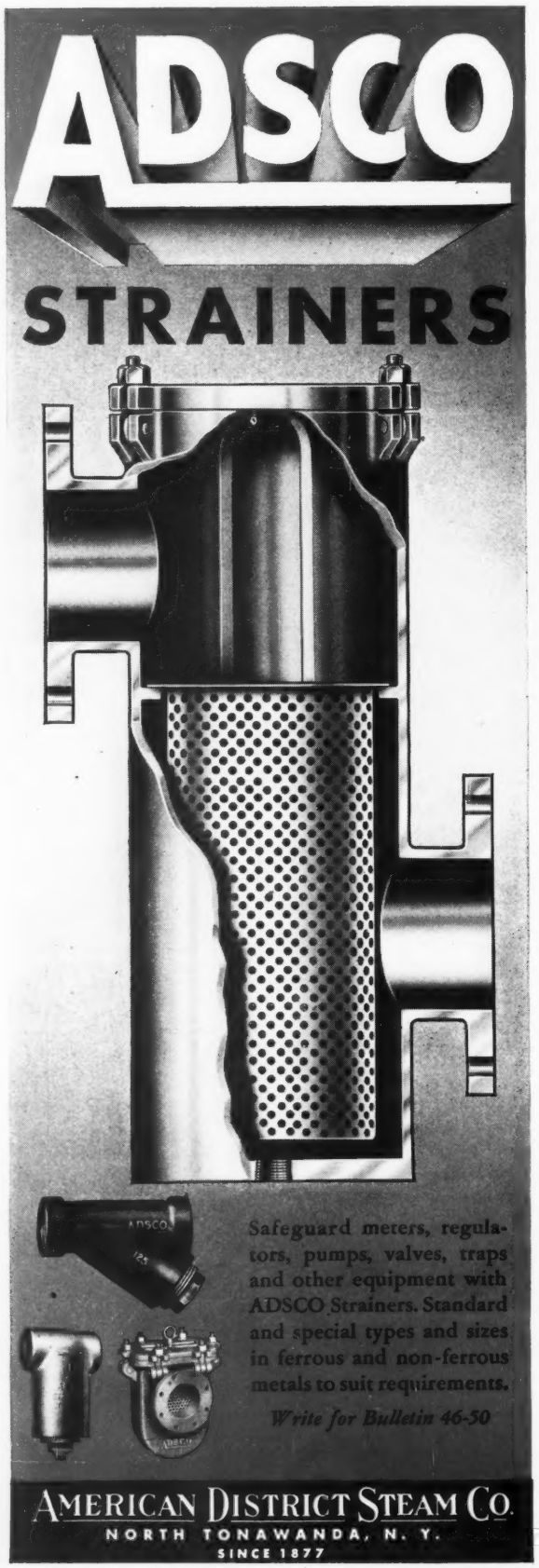


Write for booklet of tables, "Allowable Working Pressures of Tube-Turn Welding Fittings". Covers tt fittings in all sizes and regularly manufactured materials, for Power Piping, Oil Piping, Heating Piping, Gas Piping, Refrigeration Piping.

TUBE-TURN

tt

WELDING FITTINGS AND FLANGES


ADSCO
STRAINERS
Safeguard meters, regulators, pumps, valves, traps and other equipment with ADSCO Strainers. Standard and special types and sizes in ferrous and non-ferrous metals to suit requirements.
Write for Bulletin 46-50
AMERICAN DISTRICT STEAM CO.
NORTH TONAWANDA, N. Y.
SINCE 1877

ENGINEERS' PREVIEW

(Continued from page 8)

SCIENTIFIC and Technical Librarianship will be offered as an option in the Carnegie Library School of the Carnegie Institute of Technology, Pittsburgh, Pa., beginning September 1948. This is the first time a library school has ever offered such an option. It is designed to serve the needs of the several thousand special and industrial libraries over the nation. The program will cover the use of scientific and technical reference works and administrative problems in special libraries. It is a one year graduate course leading to a Master of Library Service degree. Engineers who have been concerned over the growing complexity of handling the vast and ever-increasing amount of published technical information, and who have followed the previous discussions of the subject in these pages by such library authorities as Gustav Egloff, C. R. Hammond and Margery Bedinger, will realize the importance of this forward step by Carnegie.

It must be emphasized, however, as Miss Bedinger has previously pointed out, that this field is not being neglected by the librarians. On the contrary, as reports of the recent meeting of the Special Libraries Association in Washington last June indicate, a great deal of work is being done in the field of such libraries. There is a large association of them, including specialized sections such as aeronautical engineering, pharmaceutical, the Federal Library Institute, the petroleum section, and others. Methods of indexing and classification, code making, discussion of patent office clasification and patent searchings, evaluation of periodicals and similar subjects were thoroughly discussed by more than a thousand special librarians at the meeting.

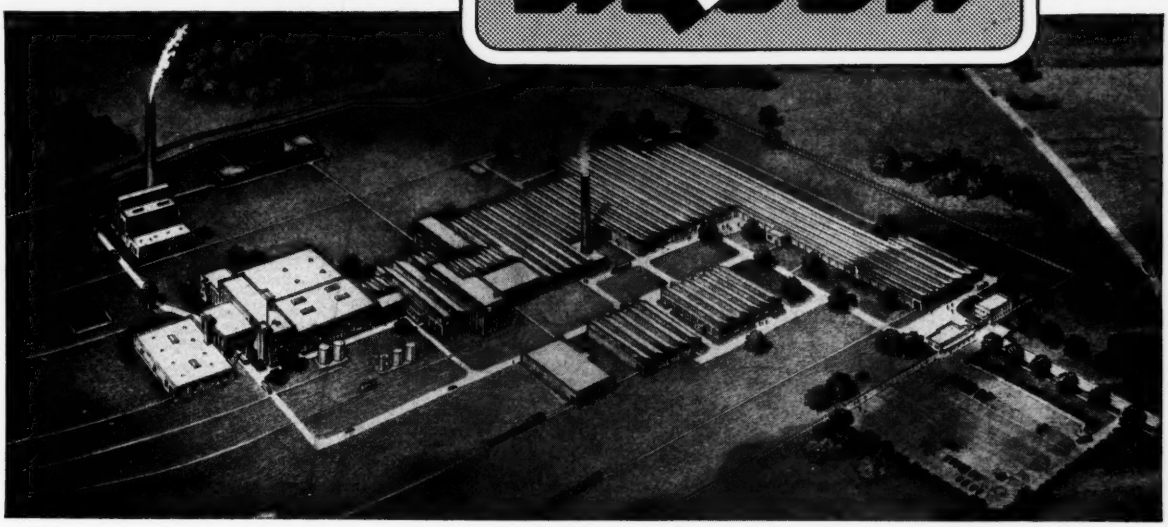
★ ★ ★

INCREASED INTEREST among individuals and manufacturers during the past months in the possibilities of the heat pump has resulted in the formation of a joint AIEC-EEI Heat Pump Committee. A wide program of investigations has been initiated or planned by many research organizations throughout the country. In working out this device, it is necessary to have a cheap and reliable source of heat. The earth and the surrounding air have both been considered for this purpose. But here we run into the difficulty that not much information is available about the various factors in heat transfer for these two media. Accordingly, the joint Heat Pump Committee is trying to co-ordinate all the information there is and to obtain more, especially on the use of the ground as a heat source. At a recent meeting, the joint committee announced the engagement of Professor William A. Hadley of Columbia University as Technical Consultant on the earth as a heat source. Professor Hadley will initiate a theoretical analysis of the transient heat transfer conditions occurring in the ground, and results of his preliminary analysis will be correlated with current experimental data. It will also help to determine the most important additional research necessary.

Many projects are now under way, or planned, to investigate this phase of heat pump use, and are reported in the ***Edison Electric Institute Bulletin.*** However, any study of the heat flow to and from the earth must be a long range program, since reasonable cycles must be considered. Consequently, some time must elapse before reliable and practical data can be expected from the research projects now in progress.

AT AMERICAN ENKA... Water Treatment Problems

Solved by LIQUON



This is one of many instances where critical consulting engineers have come to LIQUON for Water Softening Equipment because of the helpful service offered by the LIQUON engineers and chemists, the modern and efficient design of LIQUON equipment, and the prompt shipments provided by LIQUON facilities.

THE REQUIREMENTS

The Lowland, Tennessee, plant of American Enka Company uses raw river water with 68 ppm calcium and magnesium hardness, 36 ppm bicarbonate alkalinity, 10 ppm silica, and 18 ppm free CO_2. They require a present boiler feed capacity of 510,000 gpd, and 2,560,000 gpd of process water. Various problems of available water-treating materials, permissible pressure losses, and restrictions in operating costs complicated the selection of processes and equipment.

THE LIQUON EQUIPMENT

The LIQUON equipment selected by The H. K. Ferguson Company, Consulting Engineers for the boiler feed supply, includes a two-stage hot process softener with chemical feeds, and three Anthrafilt Filters. For process water, a sodium zeolite plant with 6 rubber-lined shells and automatic valves was chosen. All equipment was delivered *on time.*

•

Whatever may be *your* water treatment problems, look to LIQUON for their solution. LIQUON recommendations are backed by more than 30 years of pioneering experience in liquid conditioning of every kind—and you can be sure of prompt, efficient service from the skilled, conveniently located LIQUON field engineering representatives.

LIQUID CONDITIONING CORPORATION

114 EAST PRICE STREET, LINDEN, N. J.

Engineering Service Representatives in Principal Cities

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Please send me copy of your Condensed Catalog on Water Treatment Processes and Equipment.

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PG-7-48

NOW...USE

Coal and/or Oil and/or Gas

WITH THIS BROS COMBINATION UNIT

● Here's how you can lick today's fuel availability problems. Use this flexible *BROS* Combination Unit . . . switch to oil, to gas or back to coal *in a matter of minutes!* A unique arrangement for combination firing.

This is *BROS'* answer to today's critical problem of fuel availability. And it can free you, as a manufacturer, from the imminent threat of short supply—whether it be coal, oil or gas.

BROS engineers achieved this complete fuel flexibility by designing a steam generating unit fired by *BROS Travl-Spred* continuous ash discharge spreader stokers and combination gas and oil burners.

In the installation pictured (B. F. Nelson Mfg. Co., Minneapolis), these two *BROS* 90,000 lb. combination units supply continuous power and process steam for the manufacture of roofing paper.

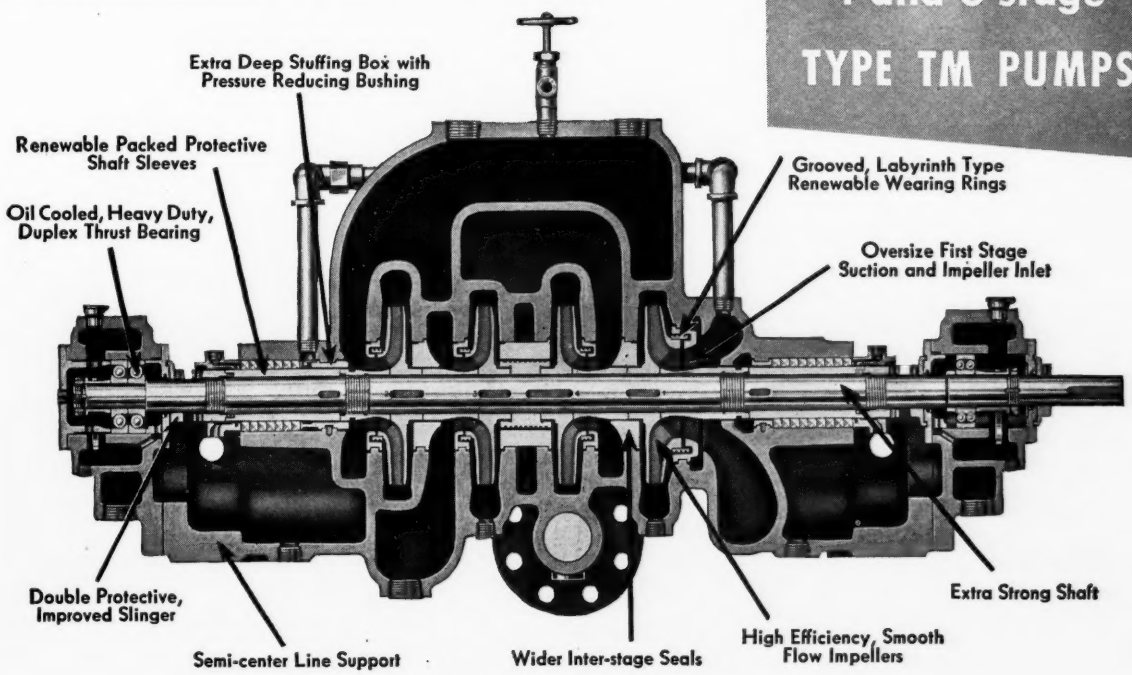
But whatever you manufacture, you can eliminate costly shut-downs just as the B. F. Nelson Mfg. Co. has. The first step is a letter to Wm. *Bros* Boiler and Mfg. Co., Minneapolis, Minnesota, for details on this *BROS* Combination Unit.

BROS

WATER TUBE, FIRE TUBE BOILERS • OVER FEED, UNDER FEED • HYDRAULIC-TRAVL-SPRED STOKERS

Here's why you get longer life, higher efficiency, greater dependability from

WARREN
4 and 6 stage
TYPE TM PUMPS


Extra Deep Stuffing Box with Pressure Reducing Bushing
Renewable Packed Protective Shaft Sleeves
Oil Cooled, Heavy Duty, Duplex Thrust Bearing
Grooved, Labyrinth Type Renewable Wearing Rings
Oversize First Stage Suction and Impeller Inlet
Double Protective, Improved Slinger
Semi-center Line Support
Wider Inter-stage Seals
High Efficiency, Smooth Flow Impellers
Extra Strong Shaft

Radial and Axial Balance

Increased dependability, efficiency and life result from Warren TM pumps being in radial balance as well as axial balance. Radial balance is achieved by having half the number of stages discharging up and the other half down, thus eliminating dangerous shaft deflections which cause excessive wear at all close fits, reducing efficiency. Axial thrust is controlled by mounting impellers back-to-back, thus avoiding troublesome balancing drum or thrust plate.

Lower Maintenance

Every possible care has been taken in design and construction of Warren Type TM Pump to insure utmost dependability and highest efficiency through elimination of danger of failure and reduction of wear to absolute minimum. Thus low maintenance is assured. Wherever wear is inevitable after long service, renewable parts are provided and all parts are easily accessible. Horizontally split case allows complete access to rotor, or its removal, without disturbing main connections.

Send for bulletin #241 . . . . . or better, send an outline of your pumping problem and get a Warren recommendation.

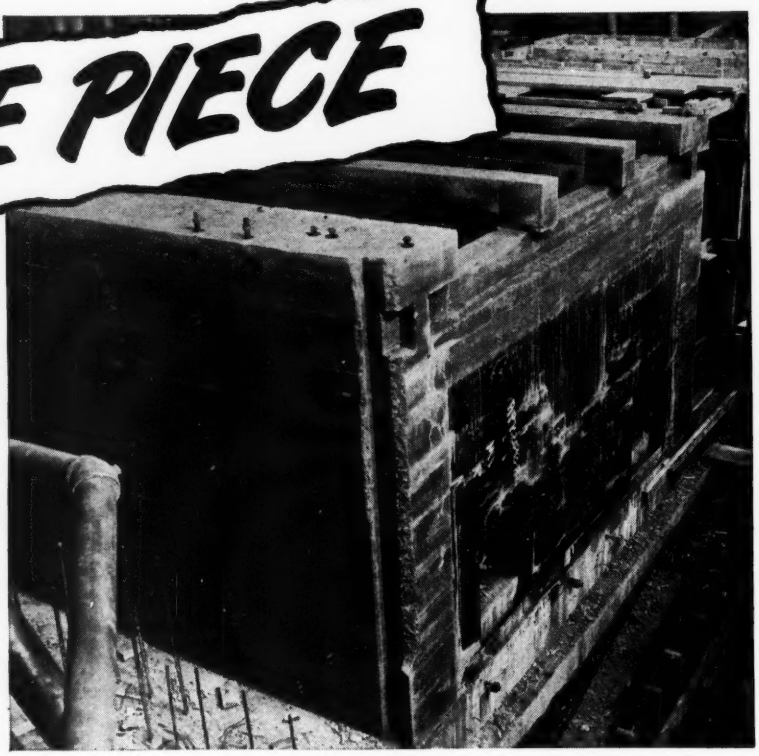
Mohawk Carpet Mills, Inc., Amsterdam, N. Y., is one of the outstanding industrial concerns where Warren Pumps are on the job. Here you see a Warren TM 4 stage pump on boiler feed service, 500# p. s. i. delivering 500 g. p. m. Mohawk has since purchased a second Warren TM Pump.

Warren Steam Pump Company, Inc.
WARREN, MASSACHUSETTS P-15

WARREN PUMPS

Boiler foundation...and Ash pit...

in ONE PIECE



LUMNITE concrete simplifies construction of heat-resistant foundation with self-lined ash pit

Built with heat-resistant LUMNITE concrete, this foundation supports boiler settings and stokers and eliminates need for separate lining in ash pits. The LUMNITE concrete withstands heat, corrosion and wear from ashes and cinders.

Monolithic, one-piece construction provides smooth surfaces without joints to wear ragged and tear out. The LUMNITE concrete, made with an aggregate of crushed firebrick, needs no refractory lining. The concrete remains sound and strong under continuous soaking heat from the boiler—it is good for temperatures well above 2000° F.

Fast construction, too, results from using LUMNITE—the rapid-hardening cement. Full load can be set on the foundation 24 hours after the concrete is placed.

Here's the best *and quickest* concrete for your boiler foundations, ash pits and many other power-plant jobs. Let us tell you how to use LUMNITE for flue and stack linings, coal-bunker linings, cinder catchers, overnight maintenance. Write us for booklets and ask us about using LUMNITE concrete on your particular job.

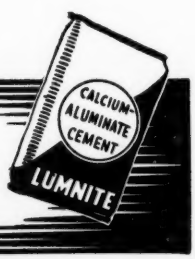
For further information, write to:

Lumnite Division

UNIVERSAL ATLAS CEMENT COMPANY

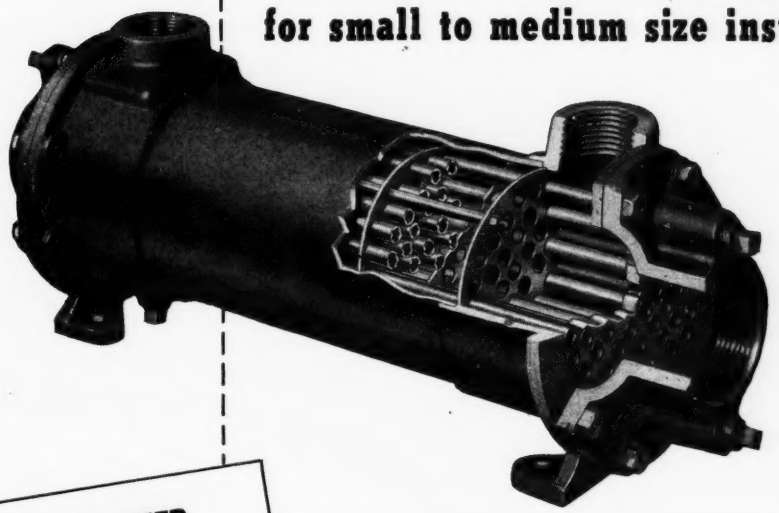
UNITED STATES STEEL CORPORATION SUBSIDIARY

135 EAST 42nd STREET • NEW YORK 17, N. Y.



"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—September to June—ABC Network*

What influences major equipment builders to use ROSS "BCF" EXCHANGERS regularly for small to medium size installations



STANDARDIZED, COMPACT DESIGNS

LOW-COST, MASS PRODUCTION

CONTINUALLY CARRIED IN STOCK

Regardless of the make, there's one point on which most manufacturers of major equipment, their dealers and customers agree: *The Ross "BCF" unit is by far the most ideally suited for small to medium size oil or water cooling requirements.*

Primarily, they like the high heat transfer efficiency packed into this compact, standardized shell and tube design; the rugged yet lightweight construction; the permanent, leakproof, mechanically made tube joints; the straight, easily cleanable tubes; and the provisions for simple installation.

Secondly, but of equal importance, they like the low-cost, mass production . . . the constant availability from stock on 24 hours notice, if necessary.

No wonder then, that it's becoming a habit with buyers of major equipment to ask: "Is a Ross 'BCF' being furnished?" You'll ask the same question if you're familiar with all the features, and you *can* be by writing for *BULLETIN 4922* today!

ROSS

"BCF" EXCHANGERS

Ross Heater & Mfg. Co., Inc.

Division of American Radiator & Standard Sanitary corporation

1428 WEST AVE. BUFFALO 13, N. Y.

Represented in Canada by Horton Steel Works, Ltd., Fort Erie, Ont.

MOST WIDELY USED OIL AND WATER COOLERS FOR DIESELS . . . GASOLINE ENGINES . . . TURBINES . . . REDUCTION GEARS . . . COMPRESSORS . . . HYDRAULIC PRESSES . . . THRUST BEARINGS . . . HYDRAULIC COUPLINGS . . . TORQUE CONVERTERS . . . INJECTION MOLDING AND DIE CASTING MACHINES

Is THIS the pump you need?

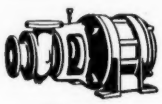
THE *Electrifugal* PUMP

IT'S COMPACT Pump and motor are combined in one rigid cast iron frame. Fits easily into close quarters—is quickly installed as a "package," and operates in any position—no shafts to align. Just bolt it down, make power and pipe connections, and start pumping. Capacities 15 to 1400 gpm, heads to 500 ft.

IT'S EFFICIENT Drip-proof motor is of Allis-Chalmers Lo-Maintenance design, specially built for pumping service. Pump has such long-service features as bronze wearing rings, new plastic water seal, five or more rings of packing, and first class construction throughout. Every unit is factory tested for efficiency, capacity and head.

IT'S AVAILABLE Many sizes of the Electrifugal and other smaller Allis-Chalmers pumps are now in stock for immediate delivery. Perhaps the size you need is ready. Phone or wire your nearest Allis-Chalmers office or dealer for up-to-the-minute information on availabilities and deliveries. For information on the complete A-C line of centrifugal pumps, ask for Bulletin B6059D. ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN. A 2381

PEDRIFUGAL
The new A-C pump for flexible Texrope V-belt drive. Capacities to 500 gpm, heads to 100 ft.



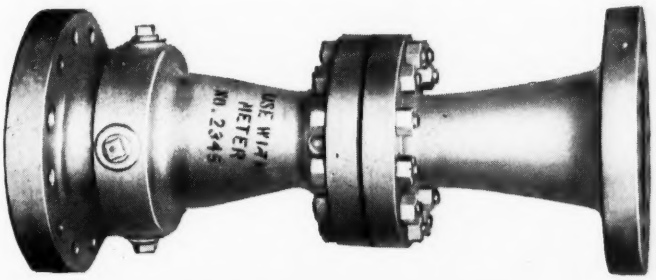
SS UNIT
Close-coupled pump and motor units, made in 234 standard ratings, to 2500 gpm.

Electrifugal, Pedrifugal, SS Unit and Texrope are Allis-Chalmers Trademarks.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

VENTURI TUBE



FOR THE GREATEST ACCURACY IN FLOW MEASUREMENT!

TYPE MO METER

The correct design and careful workmanship of Simplex Venturi Tubes insure stable coefficients over wide velocity ranges, enabling the accompanying meter to measure flow with extreme accuracy. The high efficiency in the utilization of the differential pressure head is the result of more than 40 years of manufacture and research by this company.

Simplex Type MO Meters, when used in conjunction with Simplex Venturi Tubes as primary devices, guarantee the utmost accuracy in flow measurement over long ranges. They can be furnished to measure accurately over ranges of 20 to 1, 25 to 1, 28.5 to 1 or 32.5 to 1.

Where flow ranges are long, a single meter often will be sufficient where two or more ordinary instruments would otherwise be required.

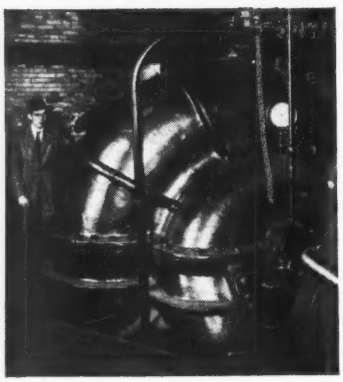
For full information and bulletins write to the Simplex Valve & Meter Company, 6783 Upland Street, Philadelphia 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

Why Consolidated Edison invested in the world's largest high Nickel Alloy pump shaft

World's largest high nickel alloy pump shaft. It was forged at INCO's Huntington, W. Va. mill, and machined by the Ingersoll-Rand Company, Phillipsburg, N. J. The forging weighed 3343 pounds. The shaft's finished dimensions were: length, 13 ft. 7⅛ in.; diameter, 9.005 in.



One of two huge centrifugal pumps installed at the 14th Street plant of the Consolidated Edison Company of New York. The pumps were built by the Ingersoll-Rand Company.

In the 14th Street plant of the Consolidated Edison Company of New York, there are two large condenser circulating pumps. They are giants of their kind, together handling 160,000 gallons of water every minute. But for 19 years, they have been ailing. The cause of their malady is the polluted salt water they pump from New York's East River. Corrosive action, plus fatigue caused repeated failures of the pump shafts.

The shafts originally installed were mild steel. These failed in relatively short time, and were replaced by others of the same metal. When these, too, failed, alloy steel shafts were tried. But these fared little better, and Consolidated Edison engineers decided the time had come to stop experimenting with metals that were not sufficiently resistant to corrosion and fatigue.

From their own experience with Monel* shafts in smaller pumps, and knowing that Monel and "K"* Monel are U. S. Navy standard metals for salt water pump shafts, the Consolidated Edison Company selected "K" Monel for this important job. This heat treatable grade of Monel provides extra strength, stiffness, and hardness for bearing surfaces.

The Consolidated Edison Company expects long and trouble-free service from this new shaft, because **MONEL** has the necessary combination of properties to withstand severe stress-corrosion conditions. **MONEL** is rustproof, corrosion-resistant, tough, and stronger than most structural steels.

INCO Nickel Alloys can extend the life of your pumps, valves, gaskets, packing, tanks, heat exchangers, and other equipment. For help in solving your power plant corrosion problems, write for "Individualized INCO Nickel Alloys." It is free.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET, NEW YORK 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO TRADE MARK ALLOYS

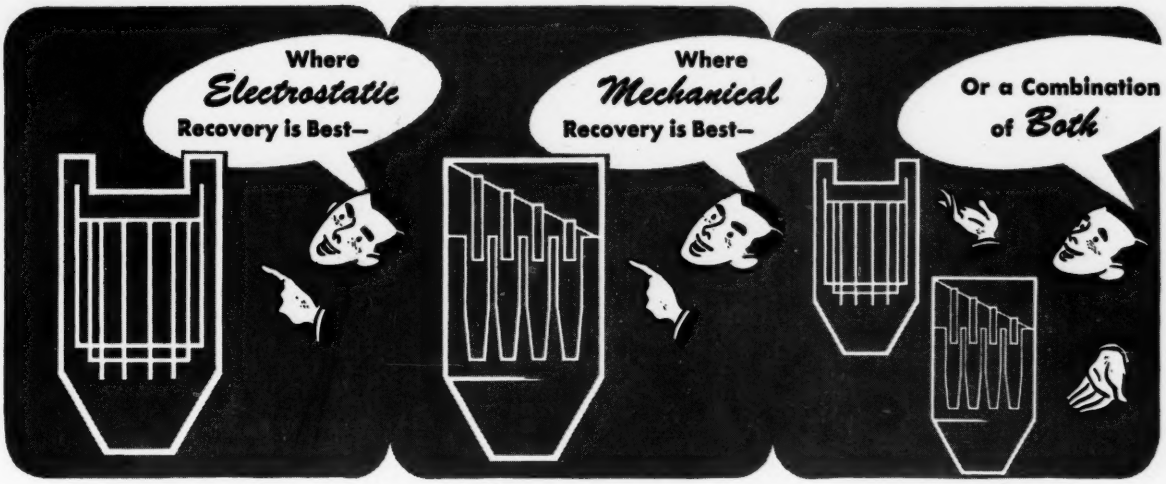
MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL
INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

*Reg. U. S. Pat. Off.

This is the UNIQUE ADVANTAGE

Western Precipitation provides for simplifying YOUR Dust Recovery Problems . . .

If you are not sure whether yours is a job for Cottrell or mechanical separation methods, you'll get an unbiased recommendation from Western Precipitation Corporation because this organization designs, engineers and installs BOTH!



THE *COTTRELL* ELECTRICAL PRECIPITATOR

Western Precipitation is the organization that pioneered the first commercial application of the now-famous Cottrell Electrical Precipitator. And its unique advancements and refinements in the basic methods, developed through more than 38 years of first-hand experience in Cottrell installations, assure you of the most modern in electrostatic recovery equipment from Western Precipitation Corporation. Cottrells handle dust, fume, fly ash, mists and other suspensions with high efficiency.

THE *MULTICLONE* MECHANICAL COLLECTOR

Companion to the Cottrell is Western Precipitation's widely used *Multiclone* equipment which offers far-reaching advantages in the mechanical separation of solids from gases. Its unique vane design makes possible multiple *small*-diameter separating tubes that combine high recovery efficiency with maximum compactness, minimum maintenance and wide-range adaptability to varying installation requirements. For mechanical recovery of solids, *Multiclone* is unsurpassed in operating efficiency, economy and installation simplicity.

COTTRELL AND MULTICLONE

And here's a priceless advantage provided by Western Precipitation Corporation . . . Frequently there are recovery problems where maximum efficiency and economy in first cost are obtained by using *Cottrell* and *Multiclone* equipment working together. There are many such recovery jobs—fly ash is one, perhaps *yours* is another—and you can get such a combination installation from one organization, under one responsibility, with one overall guarantee by bringing your recovery problem to Western Precipitation Corporation.

Send for these MULTICLONE and COTTRELL booklets!

REGARDLESS OF YOUR RECOVERY PROBLEM OR YOUR LOCATION

you can benefit by Western Precipitation's leadership and long experience in the science of recovering suspensions of all kinds—both liquid and dry—from gases, hot and cold. Western Precipitation Corporation installed the first successful Cottrell which is still in operation after 35 years of service. No matter what your industry, Western Precipitation is prepared to serve you in *all* parts of the world. Write, wire or call our nearest office.

WESTERN
Precipitation
CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1029 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 LaSALLE ST. BLDG., 1 N. La SALLE ST., CHICAGO 2 • HOBART BUILDING, SAN FRANCISCO 4, CALIFORNIA
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

NOW SELLING...

COTTRELL Precipitators
MULTICLONE Collectors
TURBULAIRE Spray Dryers

...in all parts of the U.S.A. and foreign countries.

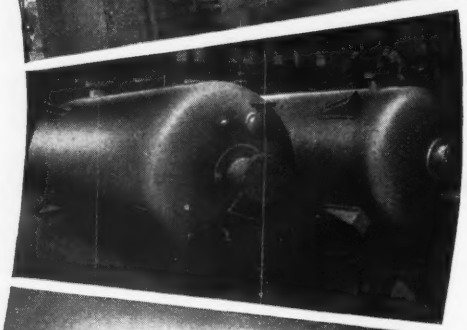
USE THESE BETTER

Vogt Products

For Today's Tough Service Demands

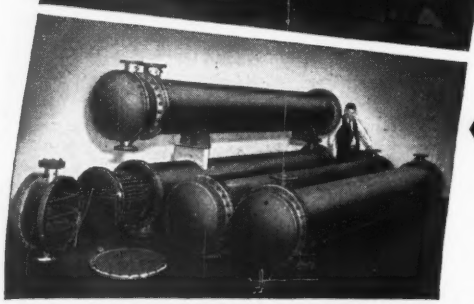
EFFICIENT AND DEPENDABLE STEAM GENERATION

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.



PROCESS EQUIPMENT FOR EVERY SERVICE

Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.

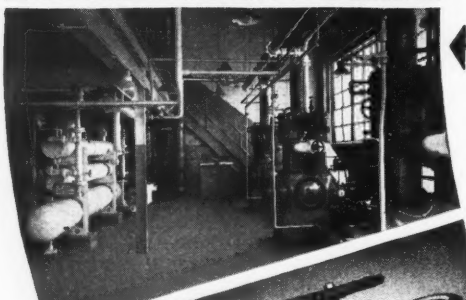


SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.

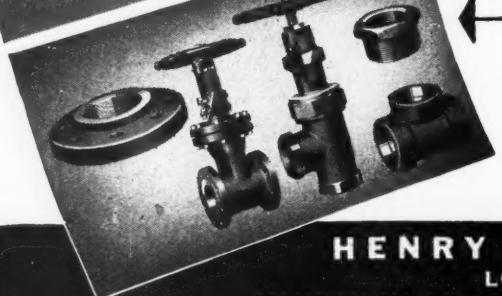
MORE TONNAGE AT LESS COST

Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.



DROP FORGED FOR EXTRA TOUGHNESS AND LONG-TIME SERVICE

Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.



Air View of Vogt Plant

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST LOUIS, DALLAS

COAL IN—ASHES OUT--One PECK-CARRIER DOES BOTH JOBS AT WEIRTON STEEL!

TWENTY-ONE YEARS OF SERVICE at Weirton's Steubenville, Ohio plant is only the beginning of a career for this Link-Belt Peck Carrier. Upper view shows coal being dumped into bunkers; lower view shows carrier receiving ashes from below boilers (ash guards removed); inset shows action of automatic dumper. This installation is duplicated at the Weirton, W. Va. plant.

VERSATILE • • • SIMPLE • • • ECONOMICAL

For coal, ashes, coke, ore, cement clinker and similar materials of abrasive nature or high temperature, the Peck overlapping, pivoted bucket carrier offers the lowest cost, most dependable type of conveying. The load is *carried*, not dragged, in pivoted buckets, which always remain horizontal except when dumping. Carrier unit elevates and conveys in a continuous flow, horizontally, vertically or on an incline, in any direction within one vertical plane.

Malleable buckets and chains resist corrosion and permit larger bearing area, without excessive chain weight.

Low travel speed, simple drive and large suspension rollers save power. Used entirely within boiler room walls, without cutting walls or roof, or erecting penthouses.

Up-to-date improvements and standardization of individual units and assemblies reduce installation and operation costs and permit flexibility in layout.

More than 50 miles of Peck Carrier are reducing materials handling costs in many kinds of plants. Learn how its features can save costs in your plant. Write for Book No. 1720 with full details.

LINK-BELT CONVEYORS

PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY

Link-Belt boiler house equipment including conveyors, elevators, crushers, weigh larries, is aiding the efficient operation of power plants for every type of industry. For information, get in touch with our nearest office.

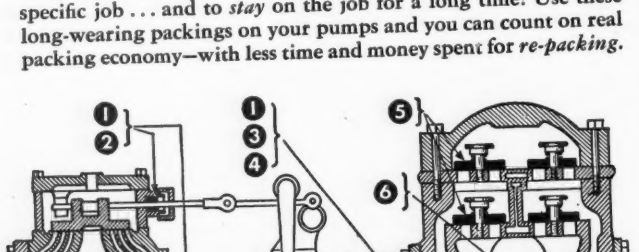
LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 11,105

How to get *Longer Service* from pump packings

"Put the right packing in the right place" is a simple but effective rule to follow if you would get maximum service life from your pump packings.

A good example of how to do this is shown below. Each of the Johns-Manville Packings listed here was designed to do a specific job . . . and to *stay* on the job for a long time! Use these long-wearing packings on your pumps and you can count on real packing economy—with less time and money spent for *re-packing*.



INSIDE-PACKED TYPE OF PUMP

(1) J-M Sea Rings—outlast ordinary packings because they seal automatically on the work stroke, release on the return.

(2) J-M Kearsarge, Style 166—a durable rod and plunger packing for service up to 500 F.

(3) J-M Cross Diagonal, Style 271 for hot water—Forms a tight seal because it is constructed to allow for expansion in either direction.

(4) J-M Navalon, Style 190 for cold water—contains and retains more lubricant in service; abrasive-free, rot-resistant, resilient.

(5) J-M Pump Valves—Provide perfect seating and long wear, for cold water service and for hot water service up to 300 F.

(6) J-M Moulded Piston Cups—Accurately moulded for precision fit, minimize danger of excessive slippage or tightness.

More complete recommendations, covering a wide range of service conditions, are contained in the Johns-Manville Packing Catalog. Ask your J-M Distributor for your free copy . . . or write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

PACKINGS & GASKETS

COMING EVENTS

ASCE—1948 Summer Convention of the American Society of Civil Engineers to be held in the Olympic Hotel, Seattle, July 21-22.

Instrument Society—Instrument Society of America annual meeting to be held in Convention Hall, Philadelphia, September 12-17.

ACS—Fifth National Chemical Exposition of the American Chemical Society to be held at the Chicago Coliseum, Chicago, October 12 through 16.

ASCE—1948 Fall Meeting of the American Society of Civil Enigneers to be held in the Statler Hotel, Boston, October 13-15.

Power Show—18th National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace, New York; November 29 to December 4.

AIEE—Pacific General Meeting, Spokane, Wash., Aug. 24-27. Middle Eastern District Meeting, Washington, D. C., Oct. 5-7. Midwest General Meeting, Milwaukee, Wis., Oct. 18-22. Southern District Meeting, Birmingham, Ala., Nov. 3-5. No headquarters announced.

ELECTRICAL ENGINEERS ELECT OFFICERS

Everett S. Lee, Engineer, General Engineering and Consulting Laboratory, General Electric Co., Schenectady, N. Y., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1948, as announced at the annual meeting of the Institute held in Mexico City, June 23. The other officers elected were: Vice-Presidents Victor Siegfried, Worcester, Mass.; John L. Callahan, New York, N. Y.; Ira A. Terry, Fort Wayne, Ind.; George N. Pingree, Dallas, Tex.; Richard McKay, Spokane, Wash.—Directors Clarence W. Fick, Cleveland, Ohio; Morris D. Hooven, Newark, N. J.; F. O. McMillan, Corvallis, Ore.—Treasurer W. I. Slichter, New York, N. Y. (reelection).

These officers, together with the following hold-over officers, will constitute the Board of Directors for the next administrative year, beginning August 1, 1948; Blake D. Hull, Dallas, Tex. (retiring president); J. Elmer Housley, Alcoa, Tenn. (past president); J. H. Berry, Norfolk, Va.; G. W. Bower, Haddonfield, N. J.; D. I. Cone, San Francisco, Calif.; I. M. Ellestad, Omaha, Nebr.; W. L. Everitt, Urbana, Ill.; J. F. Fairman, New York, N. Y.; J. M. Flanigen, Atlanta, Ga.; D. G. Geiger, Toronto, Ont.; R. T. Henry, Buffalo, N. Y.; A. C. Monteith, East Pittsburgh, Pa.; J. R. North, Jackson, Mich.; Elgin B. Robertson, Dallas, Tex.; Walter C. Smith, Palo Alto, Calif.; E. P. Yerkes, Philadelphia, Pa.

The annual report of the Board of Directors, presented at the meeting, showed a total membership on April 30, 1948, of 28,400. In addition to the winter, summer, Pacific, and midwest general meetings, and three District meetings, 2,512 meetings were held during the year by the Sections and Student Branches.

REDONDO

(Continued from page 57)

control regulating valve to the pump suction.

A quick closing solenoid operated valve is installed downstream of the constant differential pump and arranged to close automatically on a dangerously low oil pressure and also arranged to close on fan failure. A purge interlock prevents this valve from opening until dampers are opened and fans started and the furnace purged of gases.

Heating steam controls to the fuel oil heaters are of the two-element type, responsive to both heating steam pressure and fuel oil exit temperature. The steam pressure control will give rapid response on quick load pickup, while the slower acting temperature control will reset the fuel oil exit temperature to the standard value required by the viscosity of the fuel oil then being burned.

Although it may be only a remote possibility, the station has been designed so that pulverized coal burning equipment can be installed should the necessity arise in the future.

Turbine Plant

The two main turbine generators installed in the first section are each rated 60,000 kw, with overload capacity to 66,000 kw. Each is an AIEE-ASME Preferred Standard 3600 rpm unit designed for 850 psig and 900 F initial steam conditions with 1.5 in. Hg abs back pressure, except that the overload condition is based on 2.5 in. Hg abs back pressure. The hydrogen cooled generators are rated 70,588 kva, 0.85 pf, 13,800 v, 3 phase, 60 cycle. In addition to the conventional load and frequency control governor, overspeed emergency governor and low vacuum trip, each machine is provided with the special governors required for emergency quick load pickup. A low initial steam pressure regulator, normally inactive as long as the initial steam pressure remains above a set minimum value, automatically cuts in on drop of steam pressure due to a sudden demand for increased boiler steaming rate. This regulator automatically repositions the turbine steam control valves until a steam flow is established which the boilers can supply. When the firing rate has increased sufficiently to permit the boiler steam output to return to normal, the steam pressure will rise and the turbine initial pressure regulator will release the control to the speed governor.

A low load limit control, a high load limit control and a low frequency release are also provided. Under certain conditions it may be desirable to limit the maximum output of the turbine. This is done by

How to get

Prompt Service

on any packing

Typical stock of a Johns-Manville Packing Distributor

"See your Johns-Manville Packing Distributor" is a good rule to follow when you need packing in a hurry.

Located conveniently near you, he is one of 400 industrial distributors who stock Johns-Manville Packings in many sizes and styles. He not only offers you quick service and prompt delivery, but he is ready at any time to assist you with a particular packing problem. His recommendations are based on Johns-Manville's wide experience in the manufacture and application of industrial packings.

Only authorized Johns-Manville Packing Distributors can display the sign shown above. Look for it the next time you need packing!

Your Johns-Manville

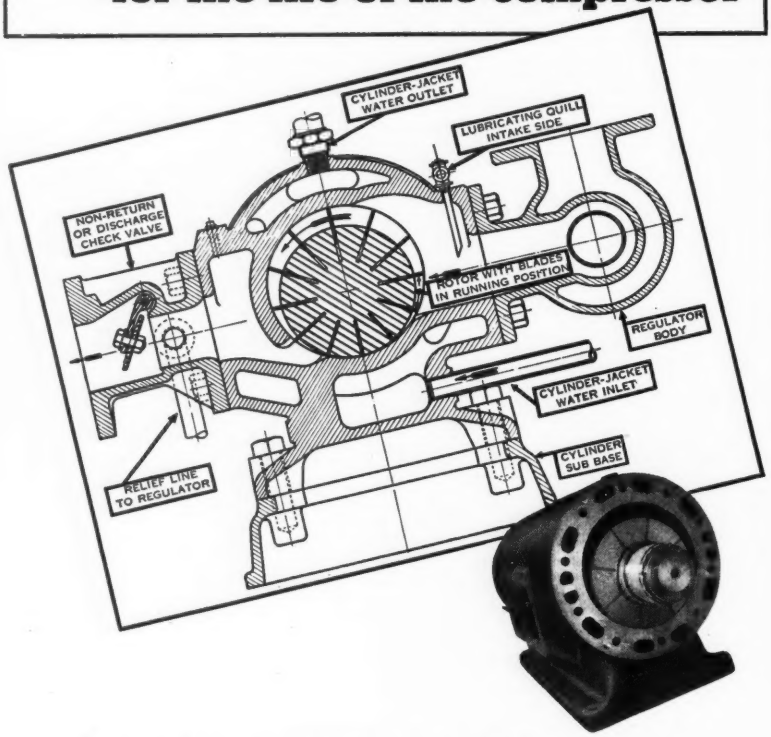
PACKING DISTRIBUTOR

JOHNS-MANVILLE JM PRODUCTS

Original

Capacity Maintained

for the life of the compressor



Due to design and construction, the blades in a Fuller Rotary Compressor automatically compensate for wear, thus eliminating the possibility of loss of capacity. Maintained capacity is just one of the many outstanding features of this machine.

There is no adjustment of valves, no grinding of seats, no take-up of bearings. No multiplicity of parts requiring frequent attention and replacement, all of which means fewer shut-downs, with attendant costly labor charges. Few moving parts: rotor—bearings—blades.

Fuller Rotaries are built for capacities to 3300 c.f.m., actual free-air delivery, pressures to 125-lb. They are fully described and illustrated in Bulletin C-5. May we send you a copy?

FULLER COMPANY
CATASAUQUA—PENNSYLVANIA

Chicago 3 - 120 So. LaSalle St.
San Francisco 4 - 420 Chancery Bldg.

C-167

Fuller
A LIFETIME OF NEW MACHINE EFFICIENCY

placing the control on the low load limit governor, which will hold a maximum load at any set value, but which will not prevent the load from falling below that point. Should the turbine happen to be on the low load limit when a sudden and large increase of load is imposed on the station, upon a predetermined drop in frequency, the low frequency release will automatically transfer the control from the low to the high load limit governor which has been preset to allow the unit to assume automatically any higher load.

One of the turbines is provided with a wide range speed control to permit operation at either 50 or 60 cycles. The frequency change-over program now under way will necessitate ability to operate one unit at either frequency.

A full complement of turbine supervisory instruments has been provided, including speed, control valve position, vibration, shaft eccentricity, cylinder expansion and spindle position recorders.

Each turbine is provided with a 42,500 sq ft surface condenser of two pass design with divided hot well. Divided water box construction has been employed to permit cleaning half the condenser with the other half in service. Condenser water boxes are equipped with inspection windows and internal illumination. Circulating water is supplied to each condenser from a pair of two-speed motor-driven vertical pumps having a combined capacity of 44,000 gpm. Each half of each condenser is provided with a set of backwash control valves for periodically reversing the flow of circulating water so that any collected debris on the inlet tube sheet may be backwashed into the circulating water discharge system, in the meantime operating on the other half of the condenser.

The first section includes one 6000 kw, 80 per cent pf, 2400 v auxiliary house generator, driven by a 7500 kw non-condensing turbine. The principal function of this unit will be to provide an emergency power supply to the 2400 v bus from which station motor-driven auxiliary equipment is fed. Such an emergency might arise on the sudden imposition of large increments of load on the station with a resultant decrease in system voltage or frequency which would cause the failure of auxiliary motor drives unless the auxiliary power were supported by a house generator. The house generator is arranged to start automatically and almost instantaneously on low voltage or low frequency in the 2400 v auxiliary system.

Circulating Water System

Circulating water is obtained from the Pacific Ocean through a pair of 10 ft ID reinforced concrete tunnels laid to a minimum depth of 4 ft un-

Chlorination...

REDUCES CONDENSER "DOWN-TIME"

When high back-pressure due to slime fouling on condenser water-side surfaces results in excessive down-time and costly plug cleaning, the best "doctor" is chlorination. Here's why:

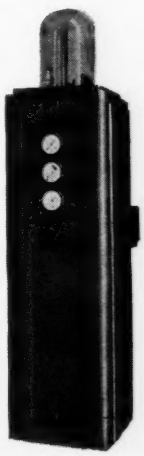
Properly applied chlorination by means of a job-engineered W&T installation is economical. In most cases, the cost of the equipment is saved in the first year.

Chlorination gets at the source of the trouble by killing the micro-organisms that cause slime deposits.

Plug cleaning is eliminated and equipment may be kept on the line thus, in effect increasing station capacity.

Fuel costs are reduced through reduction in average back-pressure.

W&T's more than thirty years' experience in water treatment are always at your call. Write today for a survey of your cooling water system—there's no obligation.



WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

CD-29

Nothing Slips by the..

HENSZEY FLOW INDICATOR

This accurate instrument goes into action as soon as the first fluid starts to pass through. It registers any rate of flow from zero to 100 per cent — instantly and accurately — as it occurs.

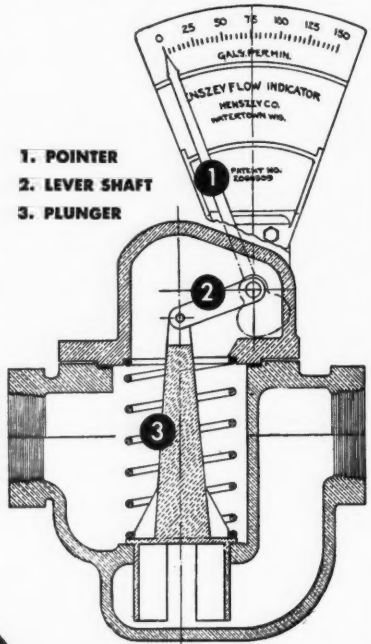
If your manufacturing process demands an accurate check on the rate of flow of liquids such as boiler feed water, condensate, gasoline, light oils, free-running chemicals etc. — plan now to investigate the Henszey Flow Indicator.

Send for special bulletin FI-1.

HENSZEY COMPANY, Dept. C-7, Watertown, Wis.

There are only three moving parts in the Henszey Flow Indicator—the Pointer, the Lever Shaft and the Plunger. And that means longer wear, continued service, and constant accuracy.

The liquid enters the indicator below the plunger, forcing the plunger upward. Slots in the side of the plunger allow the liquid to pass. Increased flow will increase the lift, exposing a greater area of the slots, so that the lift of the plunger is in direct proportion to the rate of flow of the liquid. The graduations on the dial are uniformly spaced from one end to another and read direct — without constants. The entire instrument can be installed right in the pipe line.



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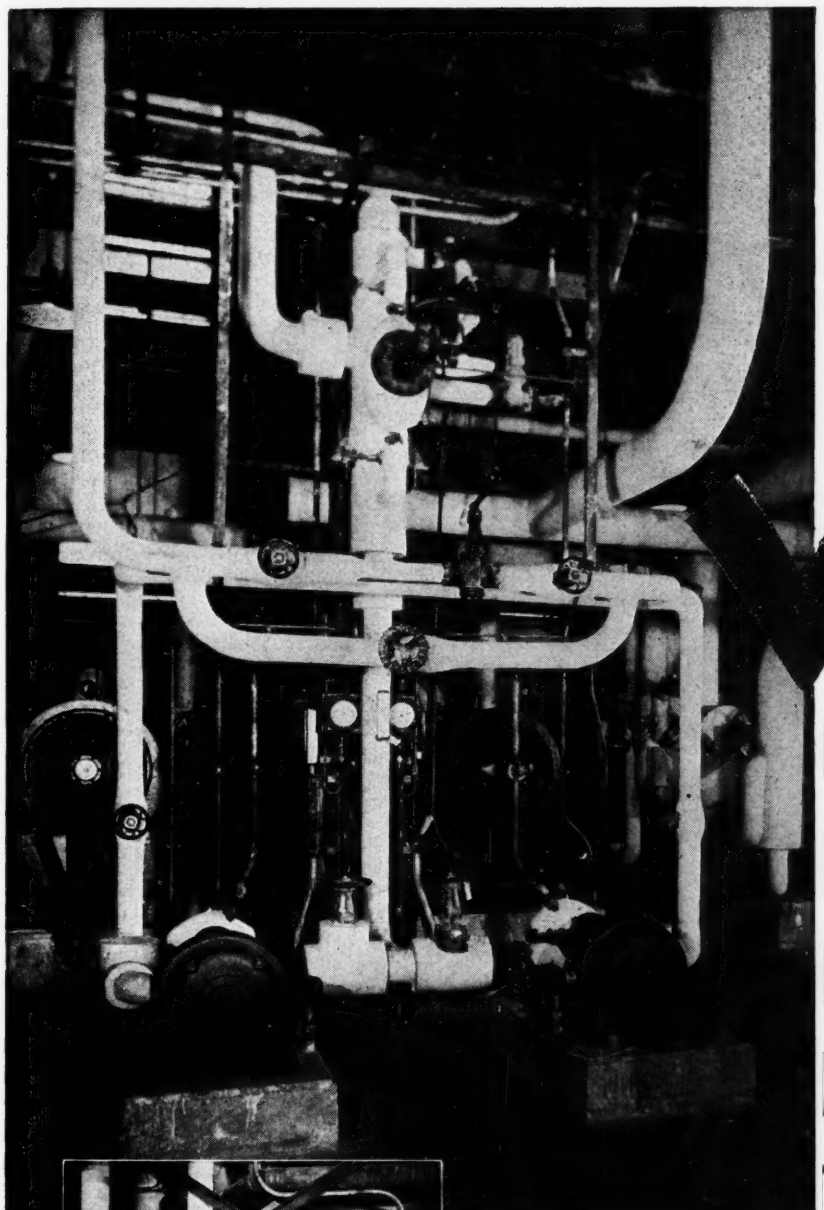
der the ocean bed and extending into the ocean about 2000 ft from the intake forebay. Water enters the tunnels through vertical towers with bell shaped top intakes located about 20 ft below mean lower low water. Tunnel intakes are placed 220 ft apart to minimize recirculation.

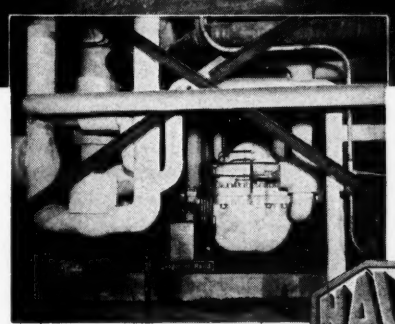
Circumstances surrounding the location of the station on the waterfront dictated the use of intake and discharge tunnels rather than an open forebay on the beach. With relatively pure sea water not contaminated with industrial waste, a fairly luxuriant growth of animal and vegetable marine organisms can be anticipated in these tunnels, unless effective means are provided for its control. Uncontrolled marine growth would seriously decrease the capacity of the tunnels and the output of the station. Various means for controlling marine growth were studied, considering the investment cost, operating practicability and certainty of control. In the plan selected, the rather unusual provision is made for periodically reversing the flow of circulating water in the tunnels so that each tunnel is alternately an intake and a discharge, thereby making it possible to chlorinate both tunnels from the land by introducing chlorine solution into that tunnel which is periodically serving as the discharge. Marine growth will therefore be controlled both by exposure to the high temperature of the discharge circulating water and to chlorine.

The tunnels have adequate capacity for handling 400 cfs of circulating water, the requirement for an ultimate of four units. The pump house and intake forebay at the inshore end of the tunnels are located on the shore side of the waterfront drive which separates the pump house from the station. This part of the installation includes a sand settling chamber, a screen well with four traveling water screens protected with trash racks and a trash rack rake, a circulating water pump well, a reversing chamber and the four vertical gates which control the alternate use of the tunnels as intakes and discharges.

Circulating water is pumped to the steam station through a separate reinforced concrete line to each condenser. The tail pipes from all condensers discharge into a common reinforced concrete tunnel which returns the circulating water to the reversing chamber. Figure 6 indicates the general layout of the intake forebay, pump well and reversing chamber.

The reversal of the flow of circulating water is effected by four vertical lift gates each 7 ft wide and 10 ft high, one located in each intake and two at the outlets of the transfer basin or reversing chamber. Gates normally operate in pairs at





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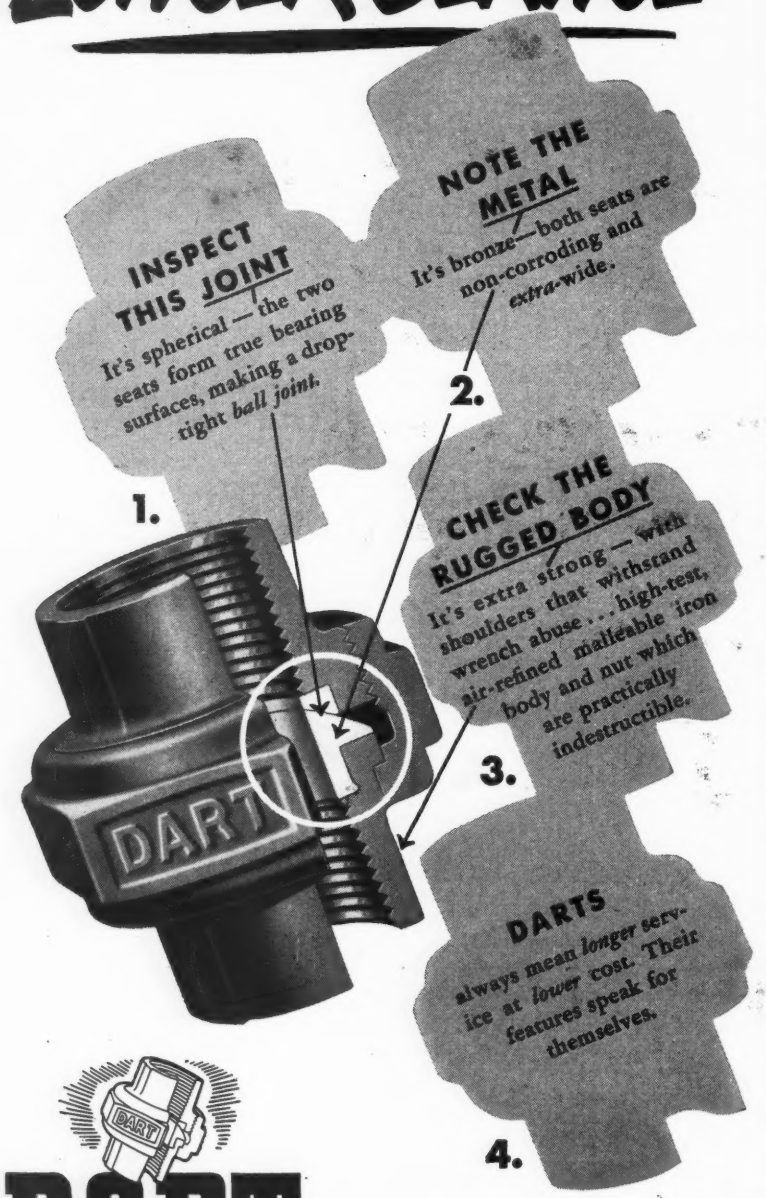
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It's spherical — the two seats form true bearing surfaces, making a drop-tight ball joint.
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uniform speed, one intake and one discharge gate opening, the other pair closing, four minutes being required to complete the stroke. Gate hoists are electrically operated with the gate positions indicated on station panel boards.

During the four-minute period of reversal, there will necessarily be a certain amount of recirculation of warmed water from that gate which has been the discharge and which is now closing, to the intake, which has been closed and which is now opening. The flow in that tunnel which has been the discharge is gradually reversing and some warmed circulating water will be drawn back into the intake. The effect of the reversal of the flow of circulating water is illustrated on Fig 7 which shows the elevation of the free water level in the forebay plotted against elapsed time following the start of the gate movement. This chart illustrates the drop in intake level and corresponding rise in discharge level for which the forebay had to be designed, and indicates the time lag required to decelerate, reverse and then accelerate the tunnel flow. Approximately 10 minutes are required for the re-establishment of equilibrium. For a short time following the gate reversal, the condensers will receive warmer than normal circulating water due to this recirculation and flow reversal in the tunnels. Warmer than normal temperature will persist for some 12 minutes with a peak rise of about 19 F prevailing for about three minutes. Calculation of the equilibrium characteristic between turbine and condenser however indicates that full generator output may be obtained during this transient period with the warmest expected circulating water temperature.

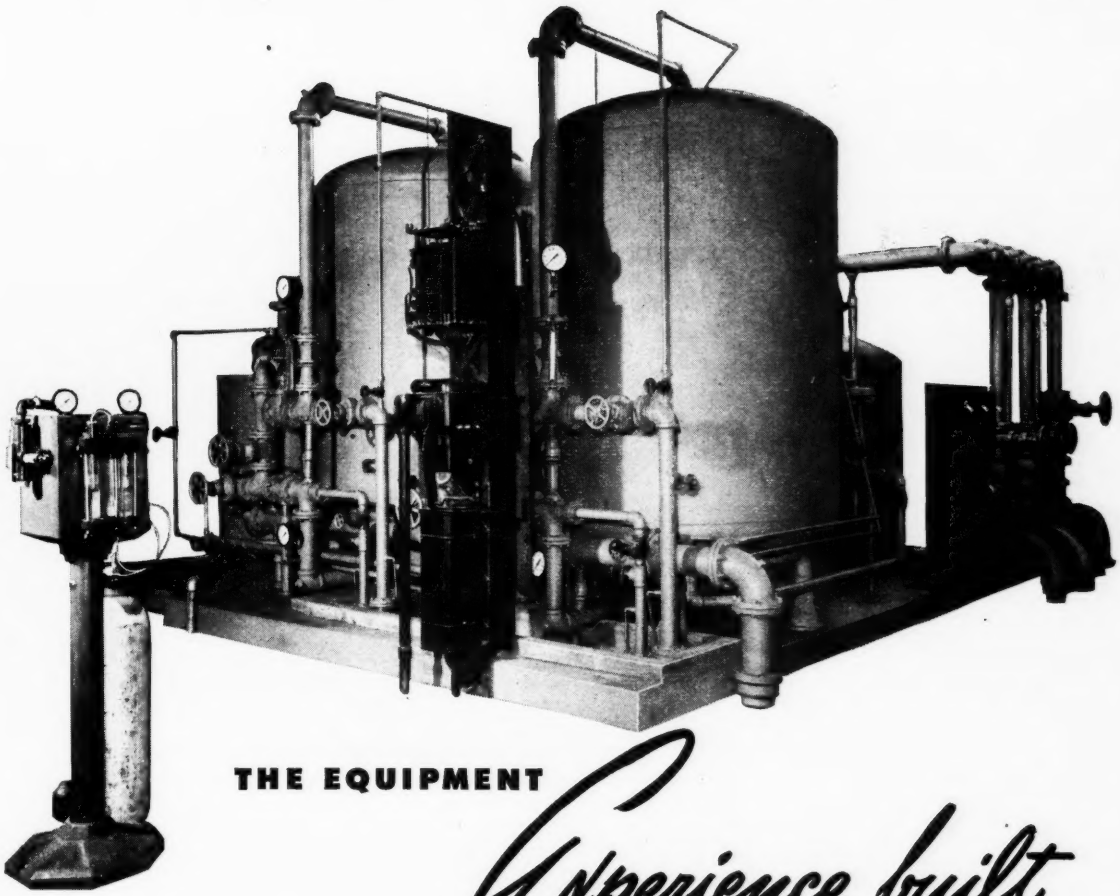
THERMAL EFFICIENCY

(Continued from page 60)

lines inside the power house unless you care to. The important point of this figure is that it shows the power house in relation to a "source of input" and a "factory" as our reasoning has indicated that this is absolutely necessary before its thermal efficiency can be calculated.

Everything that passes from the source of input to the power house is input. The fuel input from the coal pile is labeled as valuable; you have to pay several dollars a ton to get it. If you close down your power plant, you can sell your coal supply to someone else and get most or all of your money back. It is valuable.

On the other hand, the combustion air supply is not valuable, as it exists in its source outdoors. You can have all you want free of charge and everyone else can do the same. True, the temperature of this air will affect the efficiency of the power



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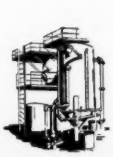

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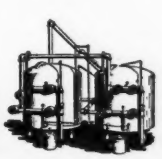

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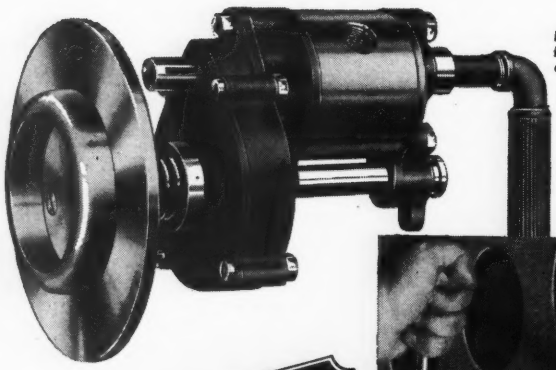
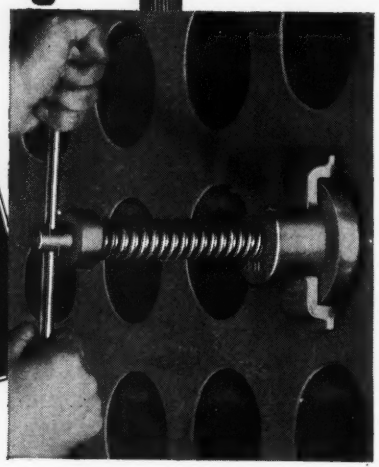


Roto Reseating Machine for boiler headers with outside caps

Clean boiler caps and headers FAST



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Tight, leakproof joints between boiler headers and caps are quickly and easily obtained with specially designed Roto tools. These tools have been used widely for many years, and are sold on a money-back guarantee of satisfaction.

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Scale, rust or other adhering matter is removed with a Roto Reseating Machine, assuring a smooth, true fit. This air-driven machine cleans headers and caps with an abrasive cloth disk fastened to a flat surface plate whose pilot ring accurately centers the disk on the gasket seat. Caps are cleaned by securing the machine in a vise and holding the cap against the disk. Three pilot rings are furnished, one for the header and two for cleaning both seats of the caps.

The inexpensive abrasive disk is easily replaceable when worn, assuring a true grinding surface at all times. The machine is light (10 lbs) and convenient to handle. It develops 1 hp at 5,000 rpm, and is geared down 5 to 1 to provide ample torque.

Send for details and prices.

for INSIDE CAPS

Roto Hand-hole Seat Scrapers can be furnished to clean standard round and oval holes. This simple, hand-operated tool is equipped with retractable knives, mounted on the end of a revolving spindle having a bearing in a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right and the job is done. A half turn to the left releases the machine. Write for bulletin and prices.

MAKE OF BOILER	TUBE SIZE	OPENING
Babcock & Wilcox	4"	Oval
B. & W. No. 40 Header	3¼"	Oval
B. & W. No. 41 Header	2"	Oval
B. & W. Superheater	2"	Round
Babcock & Wilcox	4⅛ x 5"	Square
Casey Hedges	4"	Oval
Casey Hedges	3½"	Oval
Combustion Engineer'g	3"	Round
Edge Moore	4"	Oval
Franklin	4"	Round
Geary	4"	Oval
Heine	3½"	Oval
Heine	3½"	Round
Keeler	4"	Round
Keeler	4"	Diamond
Murray	4"	Oval
Murray	3½"	Oval
Oil City	4"	Oval
Oil City	3½"	Oval
Union Iron Works	4"	Pear Shape
Walsh & Widener	4"	Oval

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plant, but there is nothing you can do about it. You have to accept the air input the way nature provides it just as you have to accept the factory electrical and steam demands as the factory lists them, which may not be what the power plant would like in order to get a high thermal efficiency. Economics establishes what part of the input is valuable and in most cases fuel will be the only input with a valuable heat content.

There is a lot of meat in Fig. 2, not so much from the standpoint of details inside the power house as from the standpoint of the relationships between the four big squares and the significance of the gaps between them. Try to get these relationships firmly impressed on your mind; they are the gist of this whole article.

Having now defined both "useful output" and "valuable input," we are ready to go inside the power house and go to work.

Finding the Heat Content of the Steam

First we will need to know the enthalpy, or heat content, of the extracted steam. This is given on Fig. 3, in which enthalpy of extracted steam is plotted against turbine throttle flow.

We will also need to know the temperature of the feedwater entering the boiler. To simplify our illustrations, we will assume that our station has no feedwater heaters although, in practice, it would probably be desirable to operate a feedwater heater from the 5 lb extraction opening. We will assume, then, that the exhaust steam condensate is returned to the boiler at 101 F (saturation temperature at 2 in Hg pressure). We will also assume that the condensate from the extracted steam is returned from process to the boiler at 210 F (18 F less than the saturation temperature at 5 psig).

In addition to the foregoing, we will need to know the losses and uses for steam and electric power inside the power house itself, if the thermal efficiency of the complete plant is to be calculated. For the purposes of our examples, we will make the following assumptions concerning these items:

Boiler efficiency = 82.0 per cent

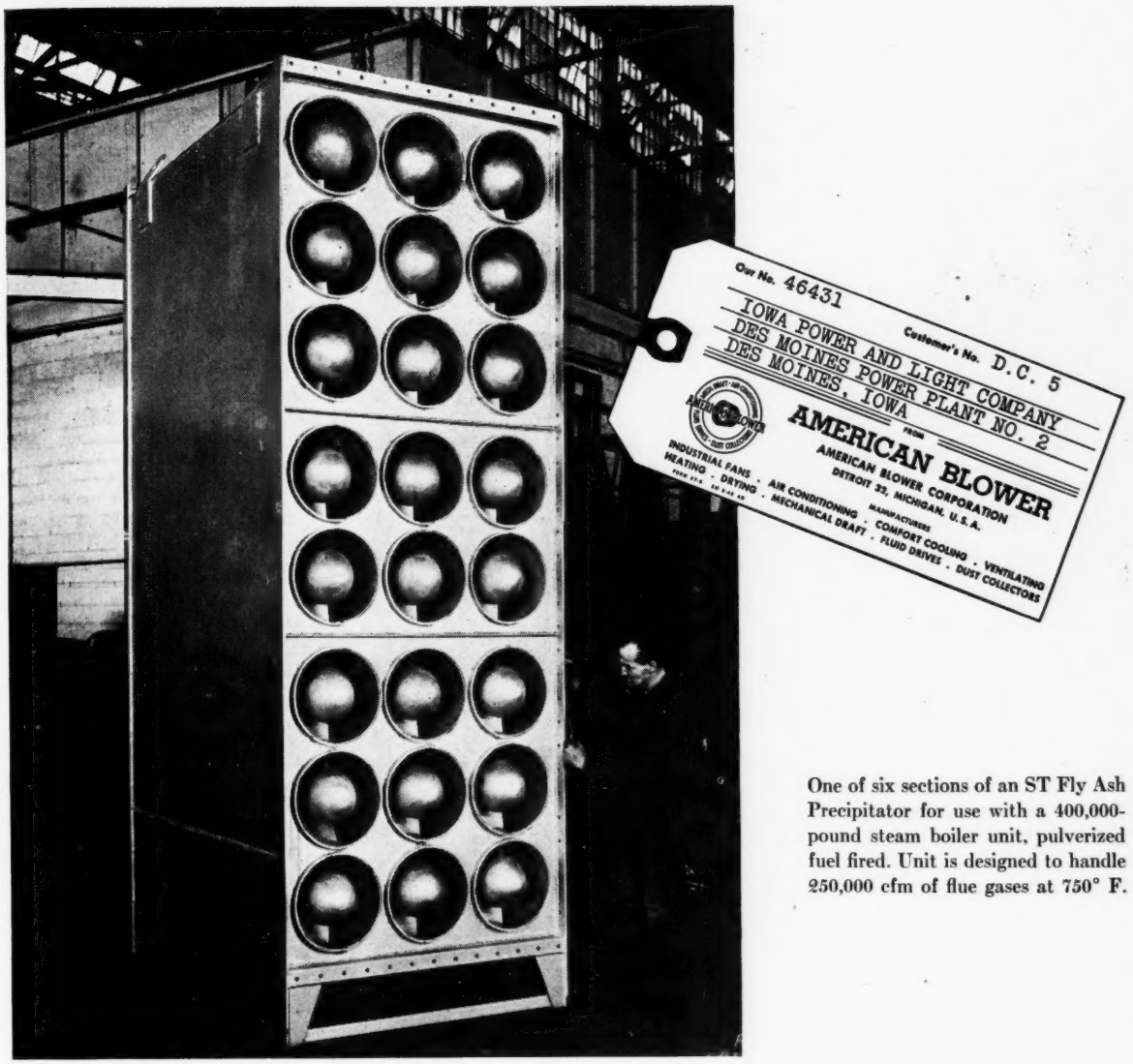
Electric power requirements of the power house itself = 100 kw

Miscellaneous steam losses and uses = 3000 lb per hr

Use of 5 psig extracted steam within the power house = zero

Pressure and temperature drops in piping and the like = neglected (in the interest of simplicity).

Feed-water makeup = 1500 lb per hr for cases A, B, C, and D. For case A^1, (here being introduced, see the next paragraph) the makeup will be 1500 lb per hr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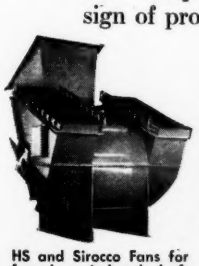
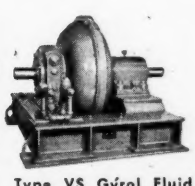


HS and Sirocco Fans for forced or induced draft in all types of power plants.

Type VS Class 6 Gyrol Fluid Drive—for adjustable speed control of boiler feed pumps.



Type VS Gyrol Fluid Drive—for adjustable speed control of mechanical draft fans.

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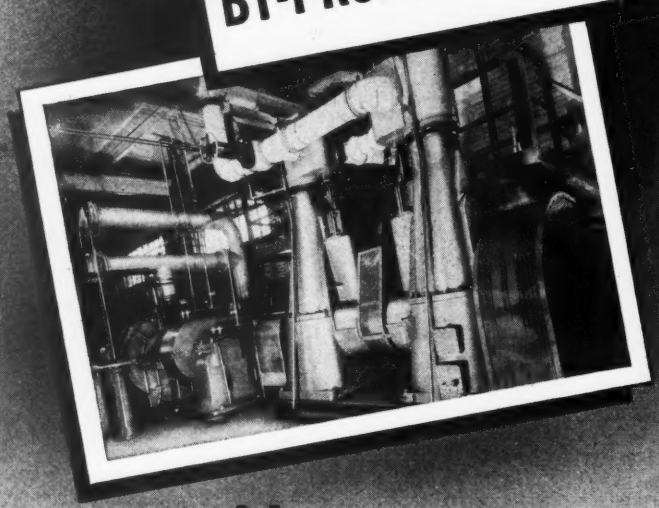

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plus the turbine extraction flow.
Temperature of feedwater makeup = 60 F

Case A^1 has been introduced to illustrate the case where power is generated by a noncondensing turbine when there is no demand for process steam. The factory requirements for case A^1 are exactly the same as for case A, namely 4900 kw of electrical power and *no* process steam; however, it is assumed that the power house generates this power by blowing 5 psig extracted steam to atmosphere instead of operating zero extraction and passing all steam to the condenser.

Tables 1 and 2

We are now ready to make the thermal efficiency calculations. To save both space and your time, the results of these calculations are summarized in Table 1 and the detailed steps of the calculations are shown in Table 2. You need not look at Table 2 unless you desire to see the details of the calculations.

Table 1 deserves some discussion. You will note that the efficiency of the plant varies from 11.7 per cent to 75.4 per cent, a very wide range. The 11.7 per cent value indicates the order of magnitude of the efficiency that can be obtained when power is generated by a noncondensing turbine and there is no demand for process steam. With a demand for process steam the heat in the exhaust of a noncondensing turbine becomes valuable and is not thrown away. The much higher 75 per cent efficiency is then obtained.

Case A shows that if the turbine is operated straight condensing to generate electric power when there is no process steam demand, an efficiency of 19.4 per cent can be obtained. If our factory never had an appreciable steam demand, by using a turbine without automatic (i.e.) pressure controlled) extraction features and adding two or three stages of feedwater heating, we might increase the thermal efficiency to 21 per cent or maybe 22 per cent or 23 per cent if the whole plant were designed carefully, but this represents about the best that can be done with a reasonably priced plant of 5000 kw rating.

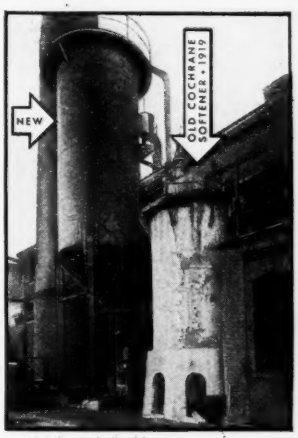
Cases B and C show that as the factory steam demands increase the thermal efficiency rapidly increases until with only cooling steam to the turbine exhaust (3000 lb per hr), the efficiency is about 75 per cent. In this case, the only losses are the boiler losses, the turbine mechanical losses, the generator losses, and the miscellaneous station losses. With careful design, these can probably be reduced to somewhat less than the 25 per cent of our illustration.

Case D shows that if the factory steam demand exceeds the turbine extraction flow required to generate the required electrical output with cooling steam only to the turbine

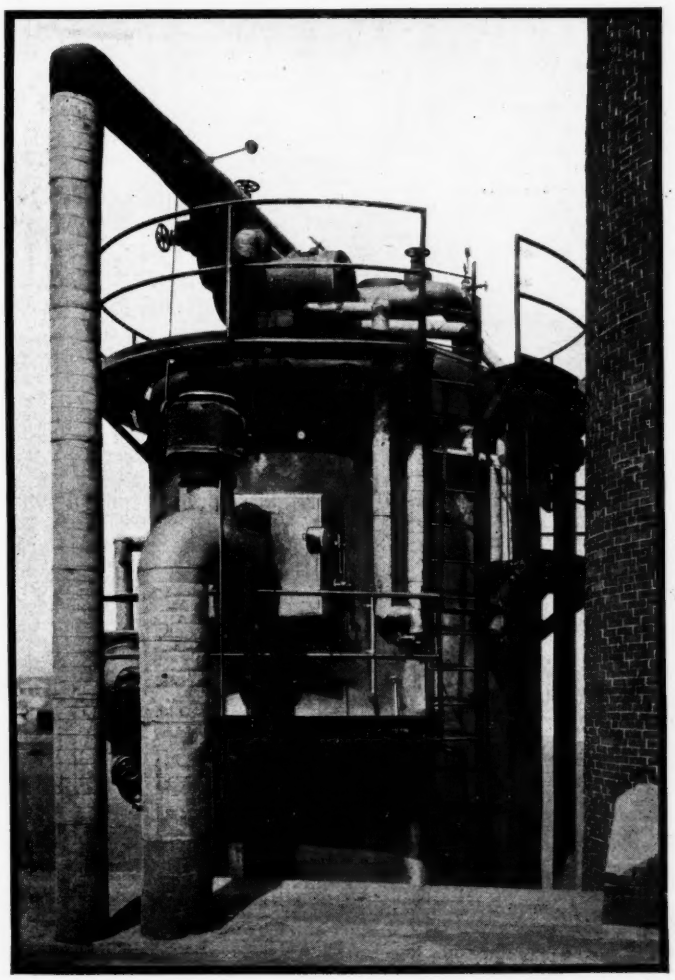
Above: Cochrane Flow Meter Panel for Automatic Control of Chemical Feed.

HISTORY REPEATS

(and Cochrane Water Conditioning Equipment)



COCHRANE Water Conditioning Equipment does its work so thoroughly, so efficiently and with so little extra upkeep costs that "repeat" orders are the rule rather than the exception. The Deaerating Hot Process Softener shown in these photographs was ordered to replace the old Cochrane Hot Process Softener shown alongside it. This older piece of equipment is still functioning, but was not able to handle the increased load. At last reports it was destined to be shifted to another job. Write for details of this installation and facts about Cochrane Hot Process Water Softeners. Cochrane Corporation 3123 N. 17th St., Philadelphia 32, Pa.



Left: Upper part of Softener showing Deaerator Mechanism and Cochrane Multiport Relief Valve.

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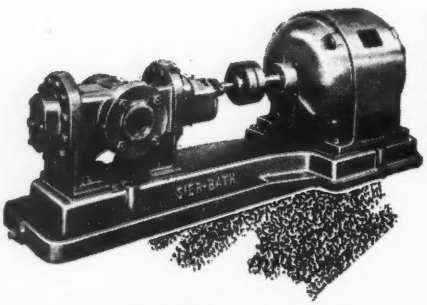

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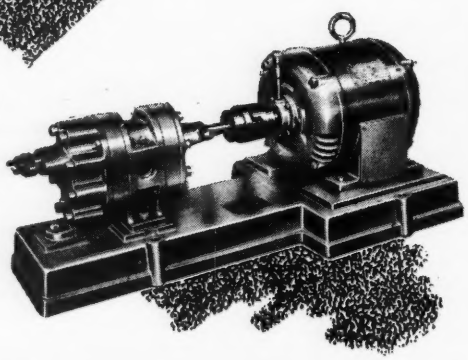

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exhaust then there is no appreciable increase in thermal efficiency as the factory steam demand increases.

Case A' shows that it is not economical to generate power by extracting steam (i.e. noncondensing turbine operation) when there is no demand for steam.

These examples illustrate the effect of factory requirements on the power plant efficiency which it is possible to obtain. They illustrate why you cannot evaluate the efficiency of an industrial power plant unless you first consider the factory, because in the efficiency equation you must limit the output to that which is useful to the factory and limit the input to that which has a valuable heat content.

The author sincerely hopes you have found this article interesting reading and that you have also found it profitable.

ATOMICS

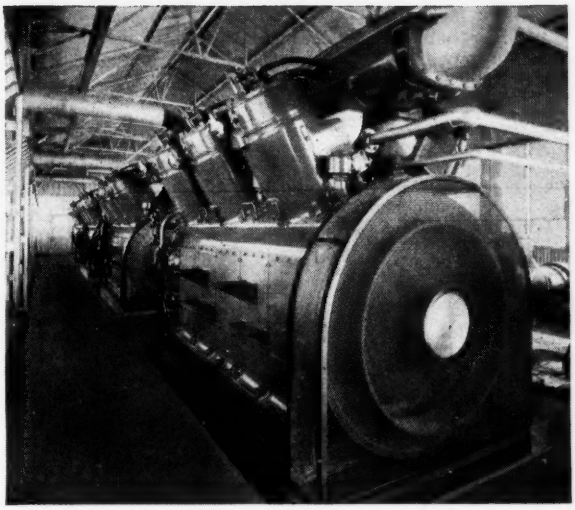
(Continued from page 63)

resources. In the light of modern chemistry, coal and oil are fast becoming commodities too valuable to be used as mere fuels, at least so far as stationary power plants and heating plants are concerned. Coal serves as the basis for some 200,000 different products. A ton of coal converted into nylon stockings is worth, retail, around $500, yet, in a modern utility plant in converting this ton of coal into electric energy, we throw some three-fourths or 1500 lb away in the condenser circulation water. Is this sensible? True, thermodynamic laws leave us little alternative, and until the last few years we had little hope of being able to do very much about this appalling waste—it is the inevitable necessary evil in the operation of a steam-electric power station.

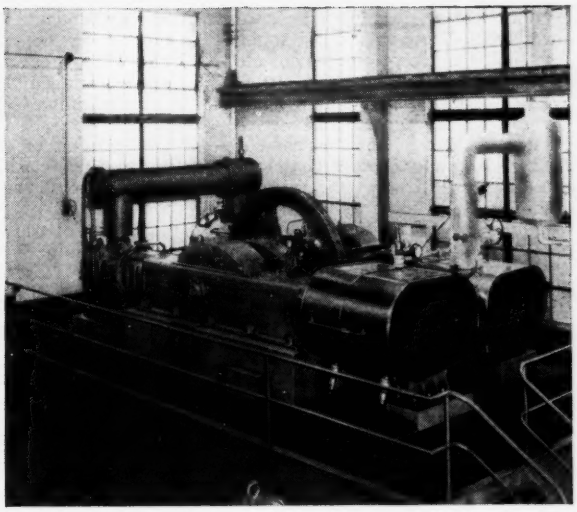
Now, however, if we really wanted to, we could start at once on a program of development that might soon enable us to eliminate this waste of fuel. This, of course, involves the development of nuclear energy for the generation of power and heat.

Nuclear Energy

As indicated in these pages in previous articles, in the controlled release of nuclear energy, man has, for the first time in history, an all but inexhaustible supply of energy. Even now, the great Hanford nuclear reactors are releasing countless billions of Btu in the production of plutonium for atomic weapons. This heat energy, however, is being wasted in slightly heating the water of the Columbia River. What is needed, is some method of releas-



The wide use of compressed air in industry focuses sharp attention on the problems of efficiency and economy of operation. Both problems are frequently controlled by the proper grade and type of lubricant used.



Regardless of the size or type of your compressor, the oils used must be carefully selected and skillfully applied. A Cities Service Lubrication Engineer will recommend up-to-date compressor lubrication methods.

Cities Service Air Compressor Lubricants are Three Ways Better!

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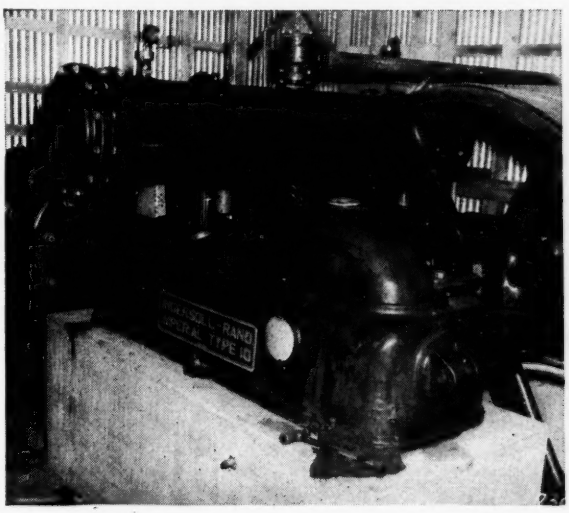

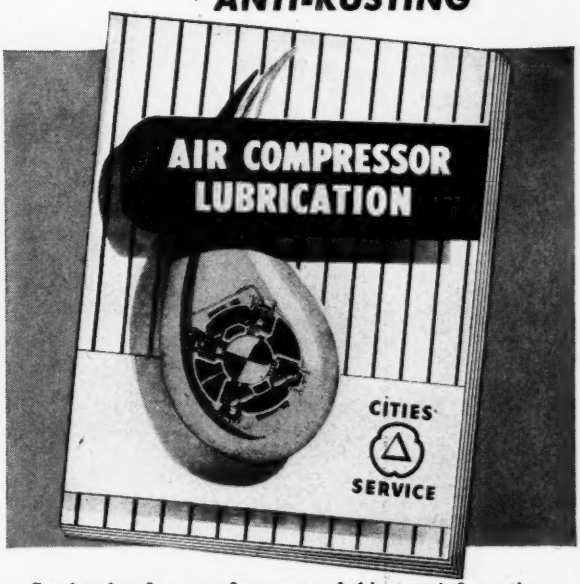

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ing this heat at a higher temperature and then utilizing this high temperature heat for the production of electric power.

The work that is being done in the development methods for producing nuclear power has been described in many recent articles in these pages. Under the direction of the United States Atomic Energy Commission, a number of research projects leading to the development of nuclear power are under way but the amount of effort and money being spent on this phase of atomic development is deplorably small compared to that which is going into the development of military weapons and methods. If it were not for the military angle, very little probably, would be done in developing nuclear power. Indeed, as this is being written the House Appropriations Committee accuses the Atomic Energy Commission of "abusing its strategic military position by engaging in general extravagance" and recommends cuts of $48,150,000 in *nonmilitary* operations but approves ample funds for new atomic weapons. Note, that the cut only affects nonmilitary operations. There is one bright aspect to this situation.

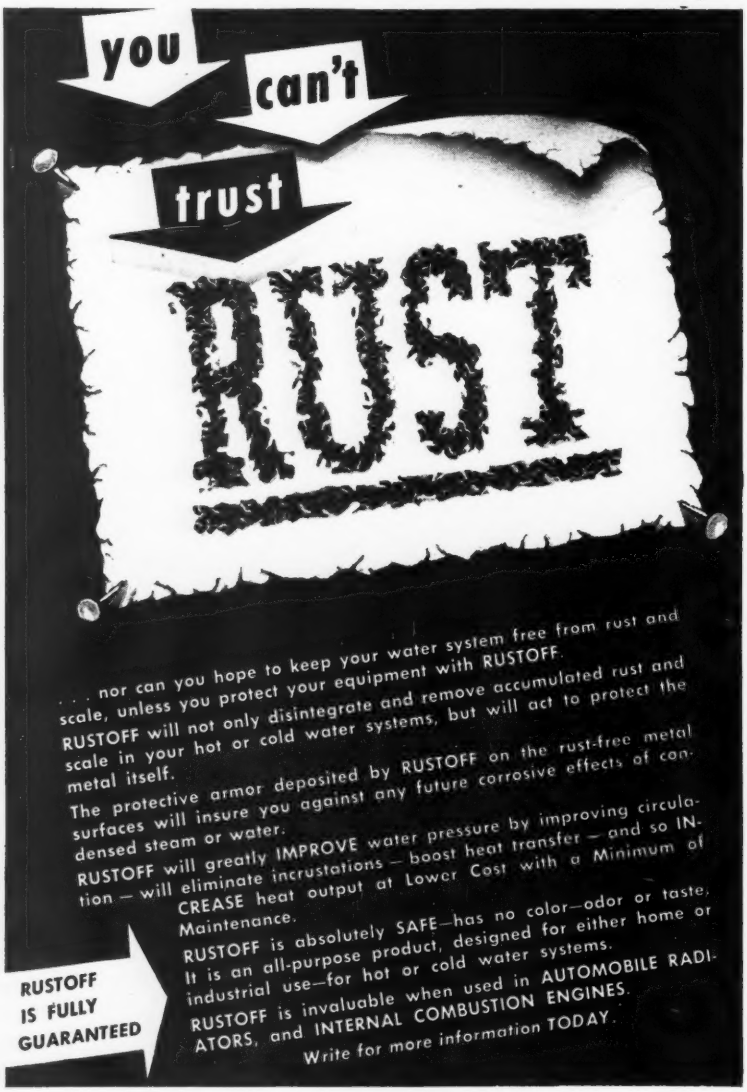
The fact that the fundamental research needed to develop military weapon is the same as that needed in the development of nuclear power gives the latter an advantage it would not ordinarily have. As disclosed in the article on the Military Influence on Nuclear Research in the June issue, just recently, the AEC authorized the construction of a new 110-ft cyclotron to cost around 9 million dollars. Compared to the 120 million dollars authorized this month for the construction of a single new bomber aircraft carrier for the U. S. Navy, the 9 million dollars for the cyclotron is mere chicken feed but it is quite certain that the Congress never would have appropriated such an amount for a mere research tool unless it had some military significance. It is a sad commentary on our intelligence.

We produced the atomic bomb from scratch in slightly over four years at an expenditure of some two billion dollars—less than two week's cost of fighting World War II. If a similar amount of money were appropriated now for the development of nuclear power plants and their subsequent construction, it is quite probable that we would be able to generate the bulk of our power from nuclear energy in a matter of 10 or 15 years, quite possibly much sooner. If, in the same manner that the Manhattan Project was carried through, this development was made a primary aim of the government during the next five years, it would go a long way toward conserving our precious fuel resources which are now being used without plan and without thought of future needs. If uranium seems to be somewhat scarce, at least so far as rich deposits are concerned, a little of it goes a long way. Forty-five tons of U-235, a cube slightly over 4 ft on a side, would supply all the power used in the United States in one year. And, as pointed out in another article in this section a few months back[1], we can use thorium and protoactinium to extend the supply of fissionable material.

Cards Stacked Against It

In making a plea for such concentrated research and development in the direction of nuclear power, I realize that there is little likelihood in the near future that such a program might be instituted. There is still too much against it—too many selfish interests and not enough understanding of the problem to assure its support. While coal, oil and gas are still relatively cheap any move to promote such a development would meet with vigorous opposition on the part of the commercial interests controlling our fuel resources. This is not so much a criticism as a fact—something basic in our system of free enterprise. Commercial power interests also would tend to oppose it unless they

[1] The significance of the Nuclear Reactor in Atomic Development, March 1948, page 90.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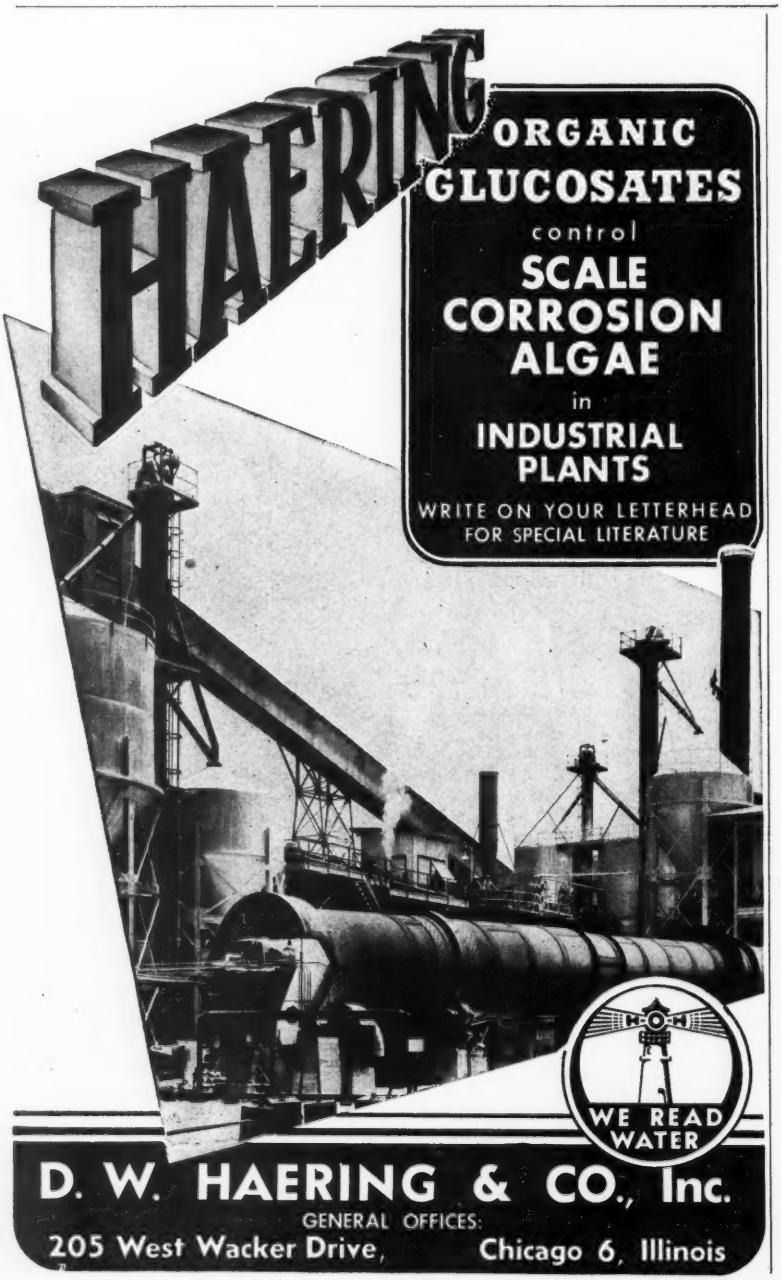
could be assured that whatever the source of energy, ordinary fuel or nuclear fission, there would be no change in the present system of private utility operation.

In short, there are many obstacles and at the present time about all that we can do is to discuss it and hope that by so discussing we will bring about general understanding of the situation and so create a willingness on the part of the people as a whole, to encourage the promotion of such concentrated development. If all the coal, oil and gas resources were to become completely depleted, say, during the next 10 years, we would lose no time in starting it—we would be at it tomorrow. As far as fuel alone is concerned, perhaps that would be a good thing, but as was pointed out earlier in this article, coal, oil and gas are valuable as raw material for many necessary products and it is to be hoped that nuclear power will be developed before all these valuable sources of material have been wasted as fuel under boilers.

Engineers, as a class, have a particular responsibility towards society in educating the public in this respect. They are the ones to whom the public looks for technical information. Only by constant emphasis and reiteration can we hope ever to get anywhere in bringing about understanding and intelligent action. In atomic energy, perhaps, we may have a power capable of reversing the march toward oblivion that Mr. Osborn describes in his splendid book.



PNEUMATIC SPREADER STOKER

(Continued from page 65)

results are obtained with sub-bituminous coals and lignite.

In operation, considering a hopper type stoker, Fig. 1, coal is loaded into the hopper by some suitable method, such as by chutes from overhead bunker, by weigh larry or other means. The feed worm, driven by motor through a transmission system to provide speed control, delivers coal from the hopper to the transfer housing. The feed screw, designed to be a measuring and sizing device, carries a special sizing section in the worm for breaking up large pieces of coal.

The coal, arriving at the transfer housing, is picked up by a stream of air produced by a high-pressure, radial-vane fan. Foreign materials may be removed through a cleanout door. Gas from the furnace is usually piped to the transfer housing. This dries the coal and dilutes the carrying air.

The mixture of coal and carrying air and gas now flows through the conveyor pipe, as shown, to the nozzle. The pre-heated air and gases heat and dry the coal. This accelerates the burning of the fires in suspension, reducing cinder carryover and improving combustion efficiency and responsiveness.

Traveling through the conveyor pipe, the larger pieces of coal gain enough momentum to carry them into the furnace where they drop by gravity and ignite on the fuel bed on the grate, while the fines ignite in suspension. The result is a shallow, hot fire, characteristic of all spreader stokers, with the ash on the bottom.

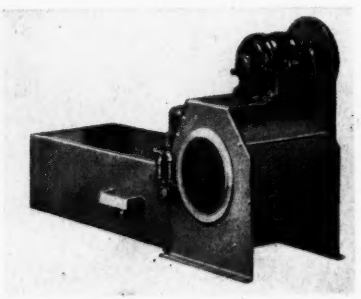


Fig. 9. Undergrate forced draft fan for pneumatic stoker, showing small auxiliary fan mounted on motor sheave for operation of Volumeter of Fig. 13

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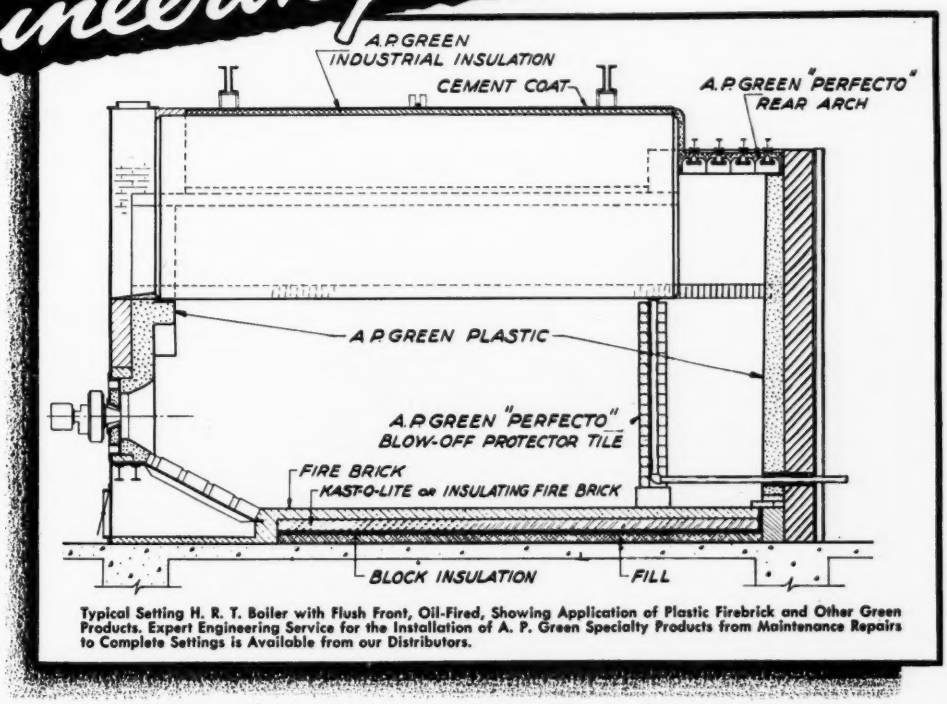

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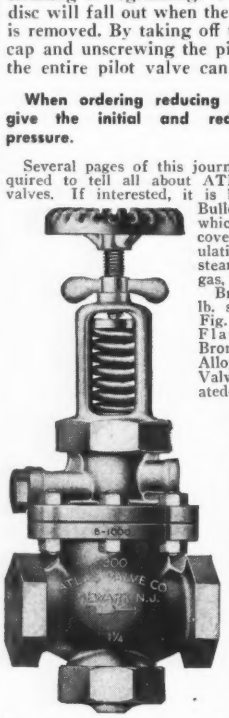
Several pages of this journal would be required to tell all about ATLAS Type "B" valves. If interested, it is best to ask for Bulletin No. 1-A which, in 52 pages, covers ATLAS Regulating Valves—for steam, water, air, gas, or oil.



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Grates and Combustion Air Supply

The grates of this stoker are constructed as in Fig. 3 in comparatively small sections combined in multiples to form the required area of the grate.

Grates may be either of a stationary type or dumping grates. Stationary grates are used where there is no sub-basement and ash hopper below the firing floor. Stationary grates are cleaned by means of a hoe and the ash is drawn into

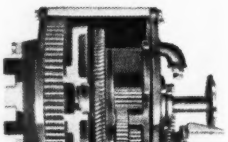


Fig. 10. Continuous feed transmission

an ash well, which is a chamber in the front furnace wall. The ash can there be quenched and later removed for disposal, thus maintaining a clean boiler room. Dumping grates, Fig. 4, are recommended in cases where the grate area is too large to be conveniently cleaned manually, and where provisions for ash storage can be made in a basement below the firing floor.

Combustion air is supplied by one or more forced draft fans, Fig. 9, which deliver it to the plenum chamber under the grates, from which it flows up through the small openings in the grates mentioned above.

This forced draft fan, as supplied by the stoker manufacturer, is equipped with an automatic regulating device known as the Volumeter Fig. 13, for maintaining constant air volume into the combustion zone with varying fuel bed thickness and different fuels, to maintain best fuel-air ratio, regardless of varying fired bed resistance. The Volumeter

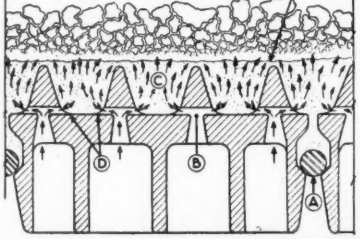
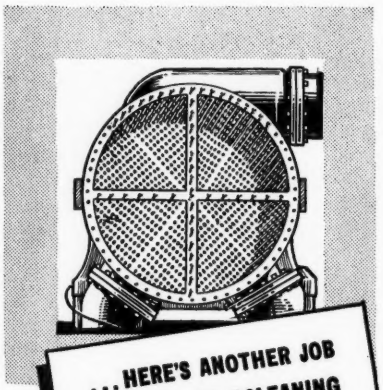


Fig. 11. Cross-section through grates. Seal A designed to prevent air leakage and riddlings between bars. Air enters through B and D, for uniform distribution. Ash, retained at C between upper ribs, holds down grate temperature, aids air distribution



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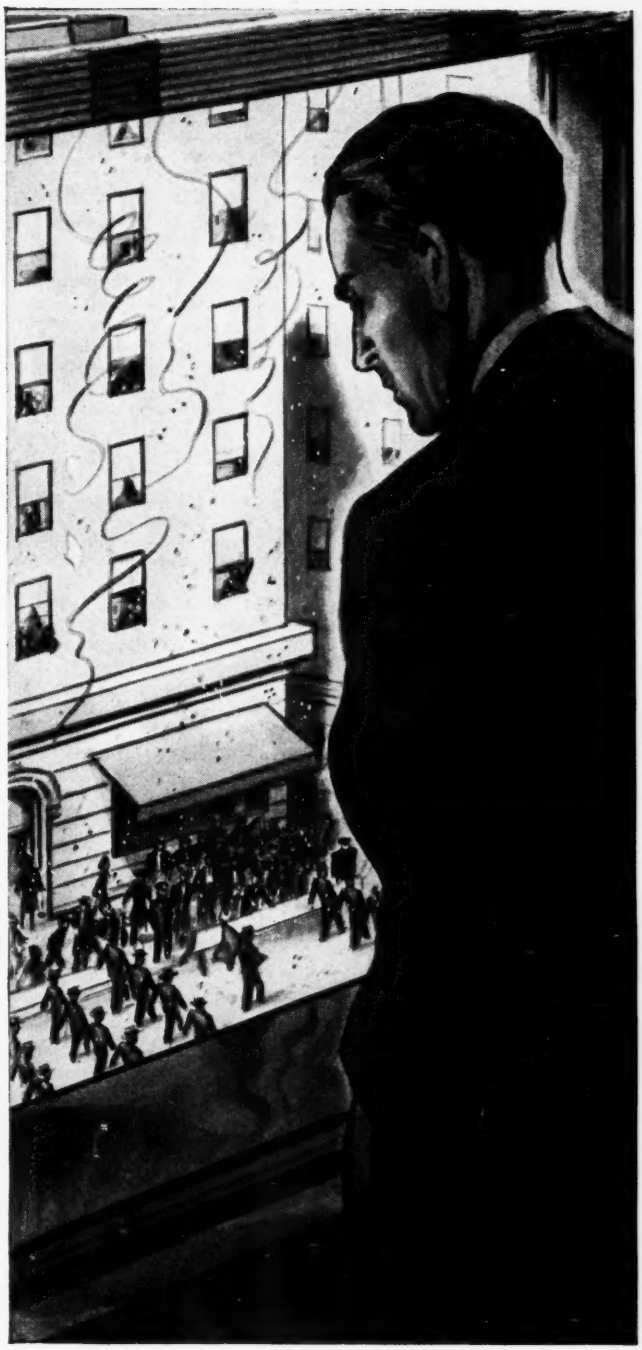
It's just as easy to take action now as when the campaign was at its height. Just call your Treasury Department's State Director, Savings Bonds Division, and ask for the material that helps to get a Payroll Plan started or to keep it rolling.



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does this by operating the damper in the forced-draft fan discharge duct.

Combustion Control

For control of combustion with fully automatic combustion control systems, a master controller, actuated from steam pressure, may be connected to vary the coal feed of the stoker by adjusting the variable-speed drive on the feeder and, at the same time, to maintain desired fuel air ratio, by adjusting the Volumeter on the forced-draft air duct. The Volumeter then operates to compensate for varying fuel bed resistance. Supplementing this is a furnace draft controller operating the boiler up-take damper to maintain constant and slightly negative pressure in the furnace.

The simplest control system, where the cost of full floating control is not justified, is the start-and-stop type, which combines a pressure regulator with an automatic refueling Timetactor to maintain the fuel bed during the off period. This system starts the stoker when steam pressure falls below the set value and stops it when the maximum operating pressure is reached. The Timetactor refuels the grates at regular intervals, to keep the fire alive during periods when steam demands do not operate the stoker.

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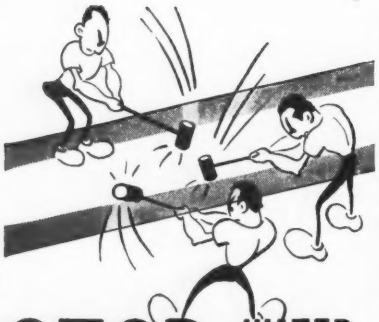

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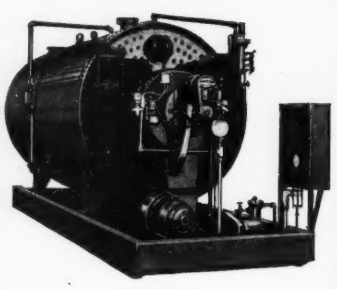

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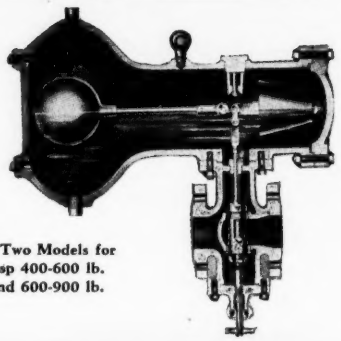

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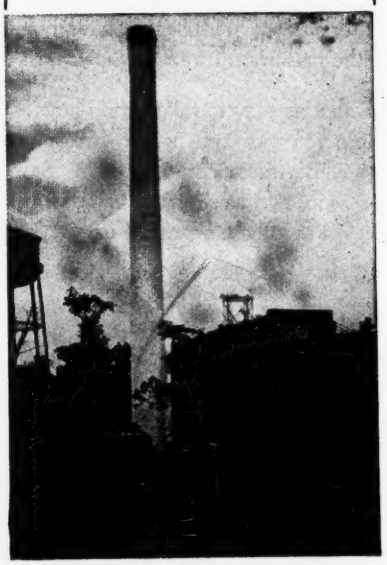

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the coal to the stoker nozzle and injects it into the furnace, also serves one of the primary purposes of overfire air—to produce turbulence in the furnace, since the air stream entering with the coal flows at right angles to the combustion gases flowing up from the fire bed.

In addition, air from the undergrate air chamber may be led, as shown in Fig. 1, to various parts of the furnace where it can be introduced as overfire air.

Details of Stoker Operation

In most installations of pneumatic spreader stokers, provision has been made for the reinjection of flyash for two major reasons:

First: To minimize the cinder discharge from the stack; Second: To avoid the necessity of cleaning boiler passes and disposing of flyash removed.

An incidental advantage is the burning of the combustible in the flyash.

All spreader stokers, both mechanical and pneumatic, are extremely responsive to load swings. Ignition is almost instantaneous, for the incoming coal falls on top of the ignited fuel bed. The mass of coal in the furnace is small, due to the shallow fuel bed; therefore load "drops" can be met almost instantaneously without increase in steam pressure. Many engineers feel that spreader stokers have almost the

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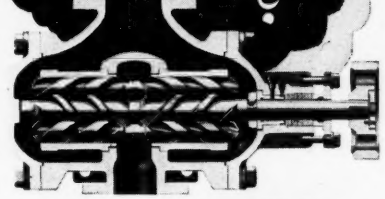

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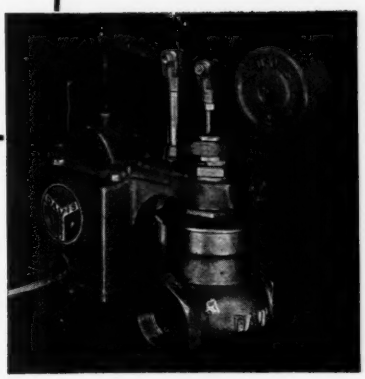

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DAVIS REGULATOR COMPANY
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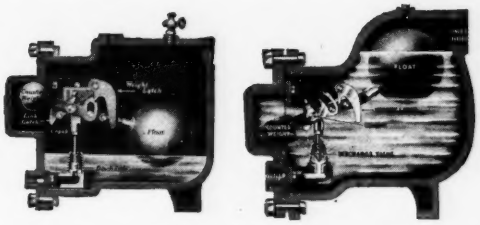
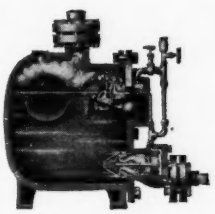
Nicholson Weight and Piston-Operated Traps Help

SOLVE CORROSION PROBLEMS

Right, Nicholson weight-operated traps for steam, air, gasoline; pressures to 200 and 650 lbs. Other models to 1500 lbs.





Above, Nicholson piston-operated steam trap, 2 to 650 lbs. pressure. Large capacity for steam purifiers, etc.

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Catalog 448 or see Sweet's

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writes user of NATIONAL GIRTH SEAM PROTECTOR

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You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

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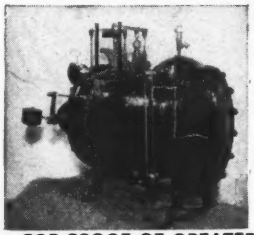
The STERLING STEAM ECONOMY lifter is AUTOMATIC . . .



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responsiveness to load swings that is found with oil, gas, or pulverized fuel.

Because the ash forms at the bottom of the fuel bed, it is not exposed to high temperatures and does not

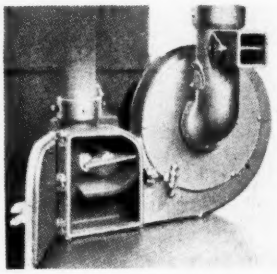

Fig. 12. Conveyor fan housing and fan intake, with clean-out door open. High-speed, narrow radial vane fan

form into clinker. The ash is light and, on stationary grate installations, can be rapidly cleaned from the grate with a hoe. This is true of all types of spreader stokers.

The pneumatic spreader stoker is extremely flexible in its application to various types of steam generating units. It has been applied to all types of fire-tube and water tube boilers.

Costs in Typical Installations

A number of typical installations are shown, with some indication of the performance obtained in actual installations. All the installations shown in Figs. 5 to 8, and additional ones not shown but described below, are on boilers not equipped with economizers or air preheaters and in refractory furnaces, no water walls being employed.

A typical installation of these stokers, under three 225-hp four-drum water-tube boilers, resulted in carrying the load for 40 per cent of the time on one boiler, with one boiler always in reserve for emergencies. Most important, the pneumatic spreader stoker burned 14 carloads less of 1¼ in by 28-mesh

Fig. 13. Phantom view of Volumeter. Air from small auxiliary fan (shown in Fig. 9) controlled by velocity vane in fan discharge duct, controls diaphragm, which adjusts fan discharge damper to maintain proper air volume independent of fuel bed resistance, by varying the pressure to maintain volume requirements

screenings at $2.11 per ton fob siding, as compared with the previous year's 2-in. nut at $2.47 per ton. This resulted in a net saving of approximately 30 per cent or $1800 in the actual cost of fuel.

In another installation, a pneumatic spreader stoker was installed under a three-drum, low-headroom type of boiler, formerly fire by fuel oil. Oil cost per thousand pounds of steam was 62 cents. Improvements were made in the baffle arrangements of the boiler and other minor changes in the furnace. The pneumatic spreader stoker burned Southern Illinois screenings, costing $4.44 delivered, reducing the fuel cost to 26.25 cents per thousand pounds or 42 per cent of the fuel cost of the original installation. In addition, $500 per month was saved in power plant salaries. Perhaps these reductions could also have been made by modernizing the oil burning equipment and providing for oil storage. However, this could not be justified because of oil costs at the time.

Another installation consists of two vertically-baffled four-drum, bent-tube boilers each with 3000 sq ft of heating surface. These units were originally fired by mechanical stokers. When they were replaced by pneumatic spreader stokers, a reduction of 26.5 per cent in fuel costs per thousand pounds of steam resulted. There was also lower maintenance on equipment and a 65 per cent reduction in power input per ton of coal burned, also less labor. With the pneumatic spreader stokers, banking coal was reduced from 5000 lb per day to about 500 lb of coal per day.

The Management Leader's Manual for Operating Executives, Supervisors and Foremen; edited by J. O. Rice and M. J. Dooher; copyrighted 1947 by the American Management Association; size 6 by 8½ in.; 190 pages, spiral bound in blue leatherette; published by the American Management Association, 330 West 42nd St., New York 18, N. Y.; price $3.00.

Alvin E. Dodd, President of the American Management Association, states in the foreword that the purpose of this manual is literally to bring the American Management Association to more people—to bring some of the best available information on human relations and operating problems to a large number who do not ordinarily have regular contact with the Association. This book is the first of a series of handbooks on the improvement of individual and group relationships in the nation's business structure, jointly written by business, scholastic and government authorities on personnel management and industrial relations. The book is designed primarily for operating executives, supervisors, and foremen whose management role it emphasizes. The seven sections deal with the management leader's human relations responsibilities, management leadership in a democracy, interviewing and counseling techniques, and means of diagnosing organization problems. Also included is a section of tests to determine the qualifications for management leadership. The manual is a compilation of articles by well known executives and managers and the volume is designed for individual reading to further knowledge of the management structure for supervisory conference training through chapter by chapter discussion as a desk manual for executives and supervisors and for general reading as an introduction to practical professional management.

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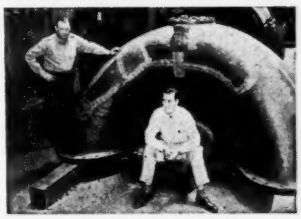

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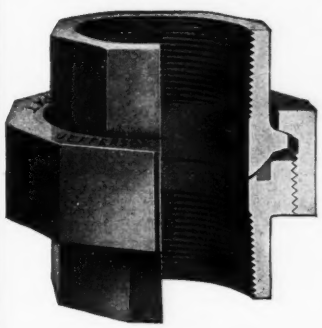

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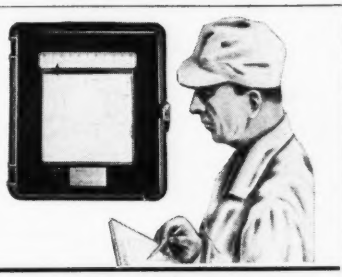

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POWER PLANT *Construction News*

Calif., Santa Clara — Owens - Illinois Fiberglas Corp., Nicholas Bldg., Toledo, Ohio, fiber glass products, plans boiler house at new branch processing and production plant at Santa Clara, for which work will begin soon. Entire project will cost close to $500,000.

Conn., Hartford—Hartford Electric Light Co., 266 Pearl St., has authorized plans for new steam-electric generating station, reported to cost over $6,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Idaho, Bliss—Idaho Power Co., Boise, Ida., has approved plans for new hydroelectric power development on Snake River, near Bliss, with power dam, generating station, switching station and other operating facilities. Cost reported over $10,000,000. Work on dam will begin soon.

Ind., Columbia City—Board of Public Works has plans under way for improvements in municipal steam-electric generating station, with installation of additional equipment, including new boiler, water-softening apparatus, combustion control facilities, etc. Entire project is reported to cost about $200,000. Douglass & Laramore, 327 South La Salle St., Chicago, Ill., are consulting engineers.

Mich, Detroit—Coca Cola Bottling Co., 3609 Gratiot St., beverages, has taken out permit for new boiler house at plant, reported to cost over $100,000, with boilers and auxiliary equipment. Work on superstructure will be carried out soon.

Mich, Onaway—Presque Isle County Electric Cooperative Assn., Onaway, has plans for addition to hydroelectric generating station on Black River, vicinity of Tower, Mich., with installation of additional equipment for increased capacity. Work will be placed under way soon, including power dam construction. No estimate of cost announced.

Minn., International Falls — City Council has plans in progress for new municipal steam-heating system, to utilize vaste steam from local power plant of Minnesota & Ontario Paper Co., with station equipment and distribution facilities. Cost about $260,000. Proposed to ask bids early in fall. G. M. Orr Engineering Co., 1004 Marquette Ave., Minneapolis, Minn., is consulting engineer.

Minn., Red Wing—Northern States Power Co., 2 South Barstow St., Eau Claire, Wis., has plans maturing for new steam-electric generating station at Red Wing, reported to cost about $4,000,000, with turbine-generator, high-pressure boiler and auxiliary equipment. Proposed to begin work on super-structure early in fall. Pioneer Service & Engineering Co., 231 South La Salle St., Chicago, Ill., is consulting engineer.

Mont., Polson—Idaho-Montana Pulp & Paper Co., recently organized, care of Tom G. Taylor & Co., Missoula, Mont., investments, plans power plant at proposed new bleached sulphate pulp mill at Polson, where large tract of land has been acquired. Entire project will include several one and multi-story buildings for processing and general production, and will represent a reported investment in excess of $5,000,000. Financing is being arranged.

Neb., Lincoln—Loup River Public Power District, Columbus, Neb., plans new power plant in vicinity of Lincoln. It is understood that Diesel engine-generator units will be installed. Work will be placed in progress soon. No estimate of cost announced.

Neb., Ord—Electric and Water Dept., is considering extensions and improvements in municipal oil engine-operated power plant, including installation of new 1000-kw Diesel engine-generator unit and auxiliary equipment. Entire project will cost about $250,000. Lutz & May, Finance Bldg., Kansas City, Mo., are consulting engineers.

N. J., Metuchen—Paraffine Companies, Inc., 475 Brannan St., San Francisco, Calif., deadening and saturating felts, linoleum, roofing, etc., is said to be planning boiler plant at new factory in Raritan Township, near Metuchen, where tract of land has been secured. It will comprise a number of one and multi-story buildings. Entire project will represent investment of approximately $3,000,000. Proposed to begin work soon.

N. J., Metuchen—Socony Paint Products Division, Socony-Vacuum Oil Co., 111 Broadway, paints, varnishes, oils, etc., plans boiler plant at proposed new factory in Raritan Township, near Metuchen, where tract of land recently was

acquired. It will comprise several units, with estimated cost reported about $3,000,000. Walter Kidde Constructors, Inc., 140 Cedar St., New York, N. Y., engineer and contractor, has award for design and supervision of erection.

N. J. Woodbridge—Shell Oil Co., 50 West 50th St., New York, N. Y., refined oils, gasoline, etc., plans boiler plant at proposed new refinery at Woodbridge, where tract of about 600 acres of land has been selected. Project will comprise a large group of one and multi-story structures, with processing and other machinery for heavy output. It will require a number of months for completion and will represent a total investment reported close to $20,000,000.

N. Y., Brooklyn—Bd. of Directors, Hospital of the Holy Family, 155 Dean St., has plans in progress for new boiler plant for central-heating service. No estimate of cost announced. Henry V. Murphy, 1 Hanson Pl., Brooklyn, is architect.

N. Y., Oswego—Central New York Power Co., 300 Erie Blvd., West, Syracuse, N. Y., plans expansion in steam-electric generating station at Oswego, with installation of new 90,000-kw turbine-generator unit, high-pressure boiler and auxiliary equipment. Work will be placed under way in near future and is scheduled for completion in 1951. Cost reported over $5,000,000. Company is a unit of Niagara-Hudson Power Corp., first noted address.

Ohio, Athens—Columbus & Southern Ohio Electric Co., 215 North Front St., Columbus, Ohio, has plans for new steam-electric power plant for service in vicinity of Athens, to be operated under direction of Athens Division. No estimate of cost announced. Work will begin soon on steel frame superstructure.

Okla., Cushing—Municipal Light and Power Dept., has preliminary plans for expansion and improvements in municipal oil engine-operated power plant, with installation of additional equipment. Estimates of cost will be made at early date, when engineer will be selected to prepare plans.

Ore., Portland—National Biscuit Co., 449 West 14th St., New York, N. Y., baked food products, plans boiler house at proposed new baking plant at Portland, where large tract of land recently was secured. Main building will approximate 350,000 sq ft floor space, and will be equipped with ovens, conveyors and other equipment for heavy output. Entire project will cost close to $6,000,000, and is scheduled for completion in 1950. Ford, Bacon & Davis, Inc., 39 Broadway, New York, is consulting engineer.

Pa., Altoona—Bd. of Directors, Altoona Hospital, Howard Ave. and 7th St., has approved plans for addition to power house at institution, used for central-steam heating service, reported to cost about $450,000, with equipment. Erection will be carried out soon. Hunter & Caldwell, 3601 Fifth Ave., Altoona, are architects.

Texas, Corpus Christi—Southwestern Oil & Refining Co., Summers St., plans power plant in connection with new oil refinery on local site. Project will comprise a number of one and multi-story structures for oil and gasoline production, and is reported to cost approximately $3,500,000. Process Engineers, Inc., 409 Ross Ave., Dallas, Texas, is engineer.

Texas, Pickton—Humble Oil & Refining Co., 1216 Main St., Houston, Texas, plans large natural gasoline plant in gas field area at Pickton. Project will include boiler plant, compressor stations, pipe lines and other facilities, and is estimated to cost over $2,100,000. Construction will be placed under way at early date.

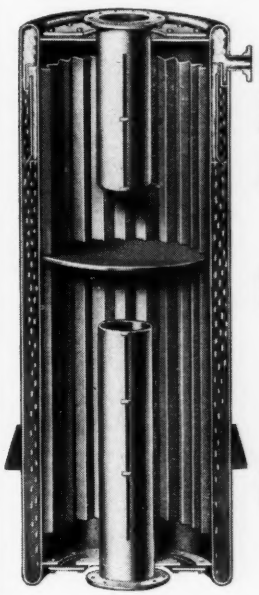
Texas, Waco—Texas Power & Light Co., Dallas, Texas, plans expansion in steam-electric generating station at Waco, with installation of additional equipment for increased capacity. No estimate of cost announced. Work on new addition to present building will be placed under way soon.

Utah, Provo—Department of Public Utilities, 7 South University Ave., has plans for expansion in municipal steam-electric generating plant, with installation of additional equipment for increased capacity. Cost reported over $350,000.

Wis., Kenosha—Wisconsin Electric Power Co., 231 West Michigan St., Milwaukee, Wis., has acquired tract of about 170 acres of land fronting on Lake Michigan, in vicinity of Kenosha, and will use as site for new steam-electric generating station. Estimates of cost will be made in near future. No time as yet announced when project will be placed under way.

Wis., Tomahawk—National Container Corp. has plans under way for addition to power plant at local kraft paper mill, with installation of equipment for increased capacity. Estimates of cost are being made. Helmick, Edeskuty & Lutz, Essex Bldg., Minneapolis, Minn., are consulting engineers.

Wis., Waupun—State Dept. of Public Welfare, State Capitol, Madison, Wis., has plans nearing completion for new power house for central-heating service at State Prison and Central State Hospital, Waupun. No estimate of cost announced. Proposed to begin work at early date. Roger C. Kirchhoff, State Capitol, Madison, is state architect.



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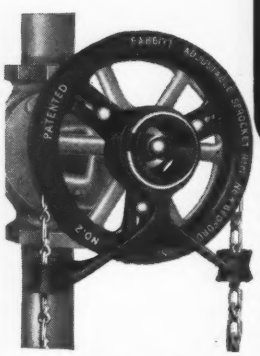

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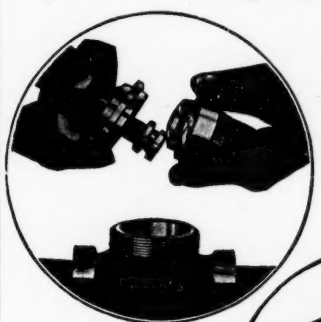

In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

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...in a

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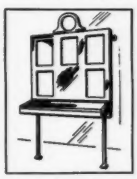

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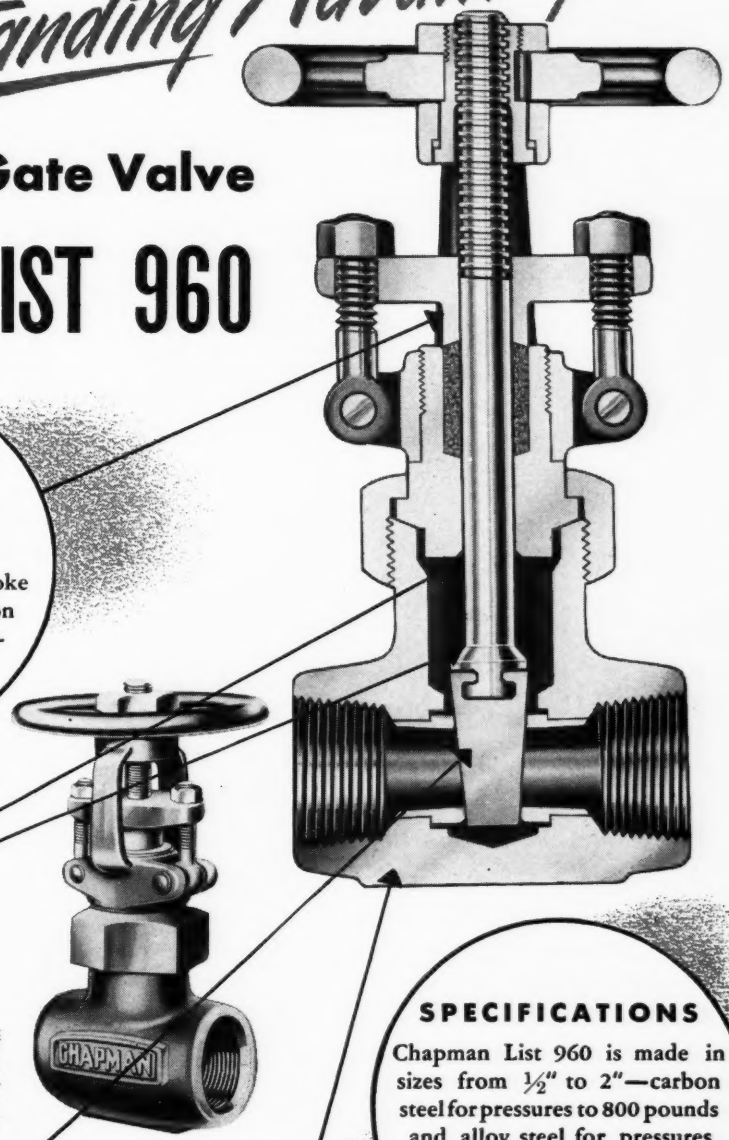
4 Outstanding Advantages

of this Sturdy Gate Valve

CHAPMAN LIST 960



1.

FORGED STEEL PACKING GLAND

Protects threads on valve yoke from rust and corrosion when valve is used in exposed locations.

2.

FULL PRESSURE PACKING

This valve can be repacked under full pressure because no pressure is transmitted to the valve stem.

3.

MALCOMIZED STAINLESS STEEL PARTS

All stems, plugs, and seat rings are made of Malcomized stainless steel—for extra-severe services.

4.

RUGGEDLY BUILT BODY

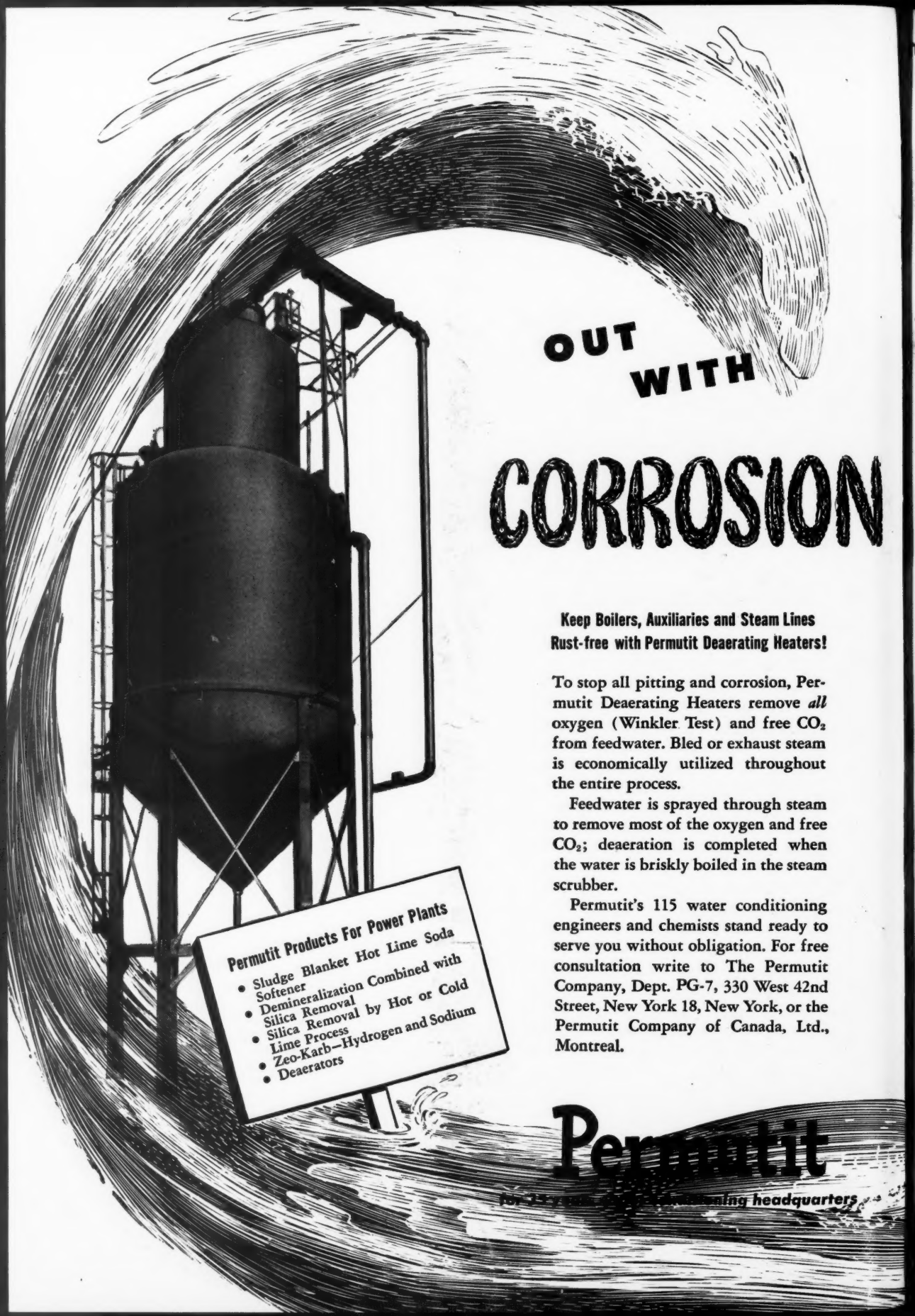
Made of strong forged steel.

SPECIFICATIONS

Chapman List 960 is made in sizes from ½" to 2"—carbon steel for pressures to 800 pounds and alloy steel for pressures to 1,000 pounds, at 750°F. For higher pressures, specify List 990.

The Chapman Valve Mfg. Co.

INDIAN ORCHARD, MASS.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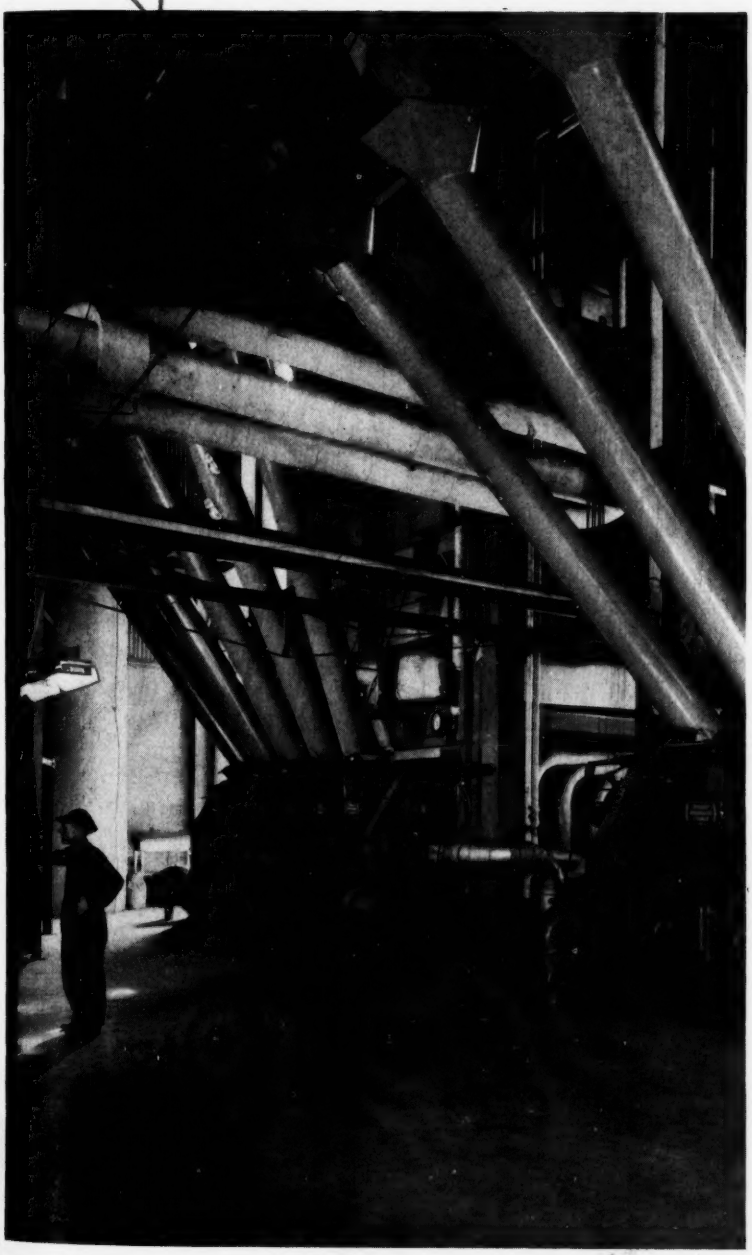

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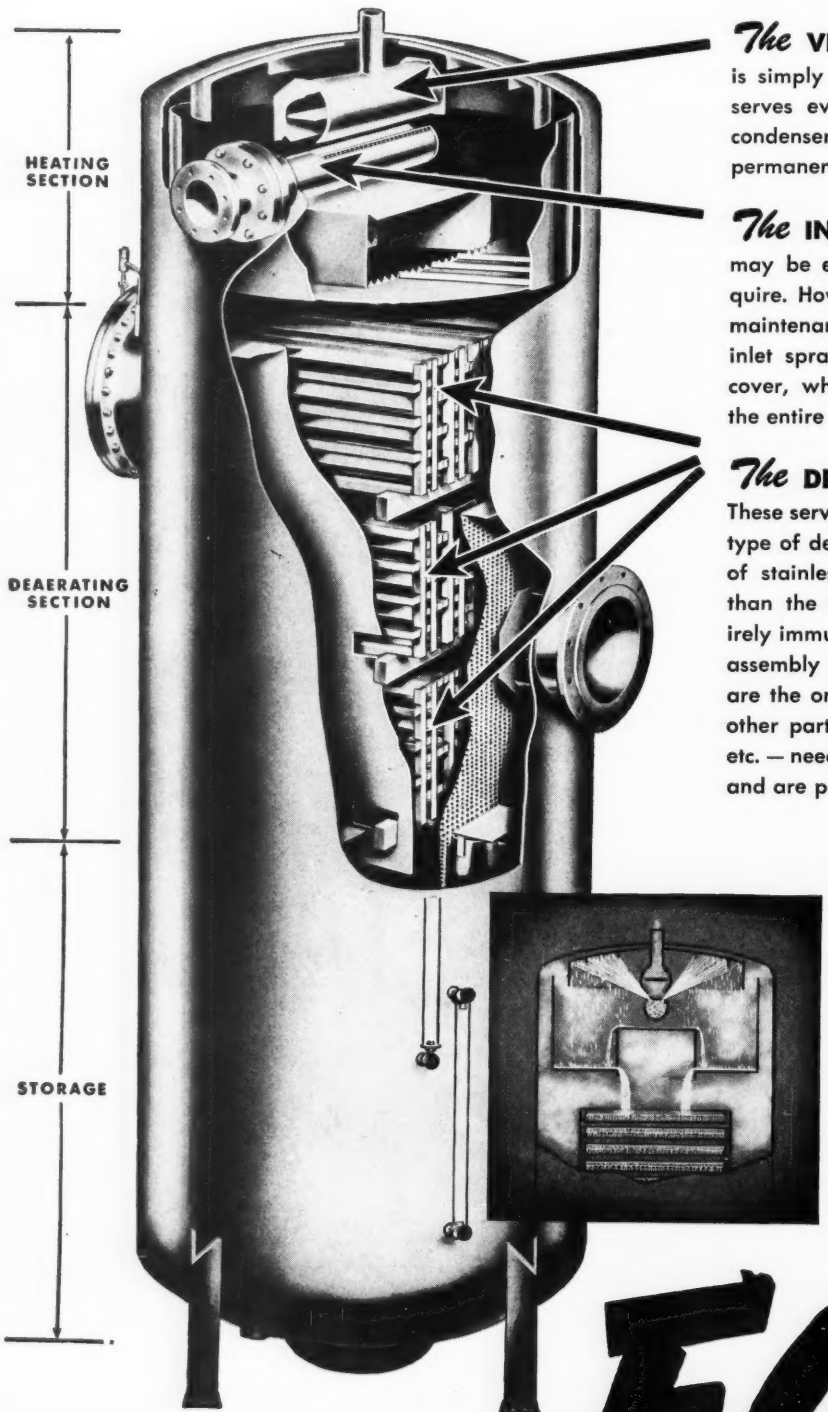
• • •

TWO FOUR-DRUM STEAM GENERATORS WITH WATER-COOLED FURNACES, CAPACITY 150,000 LB OF STEAM PER HOUR EACH, EQUIPPED WITH SPREADER STOKERS OF THE CONTINUOUSLY-CLEANING GRATE TYPE, AT NEW BOILER PLANT, CONSOLIDATED PAPER CO., SOUTH SIDE PLANT, MONROE, MICH. (Detroit Stoker Co. photo)

For Power Engineers Responsible for Supply of Steam, Electricity and All Other Power Plant Services

Again . . . Elliott



The VENT COLLECTING HOOD

is simply constructed, of stainless steel, and serves every function of the old time vent condenser. It requires no maintenance, and is permanently connected to the vent pipe.

The INLET SPRAY ASSEMBLY

may be easily removed should occasion require. However routine inspection is the only maintenance normally needed. Just below the inlet spray assembly is the access opening cover, which when removed gives access to the entire heating section.

The DEAERATING TRAYS

These serve the same function as in the former type of deaerating heater, but are fabricated of stainless steel, stronger and 75% lighter than the traditional cast iron tray, and entirely immune to cracking. With the inlet spray assembly and the access opening cover they are the only removable parts in the unit. All other parts — stainless steel baffling, nozzles, etc. — need no maintenance nor adjustment, and are permanently welded to the shell.

HOW IT OPERATES

Water sprayed through the inlet spray assembly, strikes the inner head baffling, then falls to the bottom of the heating section and is distributed over the deaerating trays. The steam flows through the deaerating trays to the top or heating section carrying with it the noncondensable gases. Since the coldest point in the unit is where the water leaves the spray pipe, the flow is to that point, pushing the noncondensable gases into the vent hood and then to atmosphere.

Elliott

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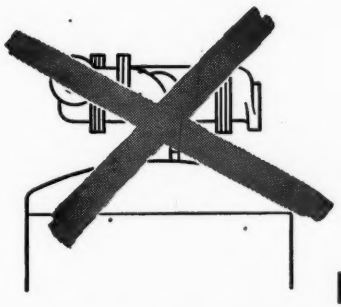
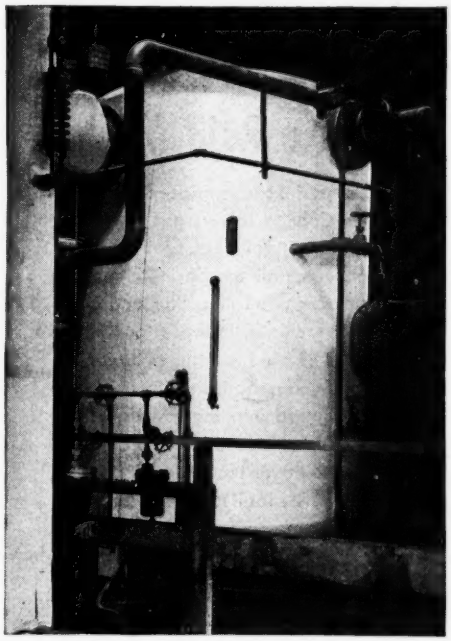
blazes a new trail



DEAERATION with NO TUBULAR VENT CONDENSER

It is fitting that Elliott engineering, which pioneered the deaeration of feedwater thirty years ago, should again take the lead in this new and vital development in economical deaeration — the elimination of the vent condenser.

The big saving is in maintenance. The tubular type of vent condenser, up to now accepted as standard, is naturally subject to attack by the corrosive gases concentrating at that point in process of removal from the feedwater. In the new Elliott spray-tray deaerating heater, the venting of these gases is handled by a stainless steel vent collecting hood, working with the inlet spray assembly. Thus corrosion, the big factor in maintenance, is ruled out of the picture.



Another obvious saving in the elimination of the vent condenser is in headroom. This is a vital consideration in some installations where a few feet can make all the difference in the correct placing of the unit.

The deaerating trays, too, in the Elliott spray-tray heater are of fabricated stainless steel instead of the conventional heavier cast iron, making handling easier, and providing stronger, crack-proof construction.

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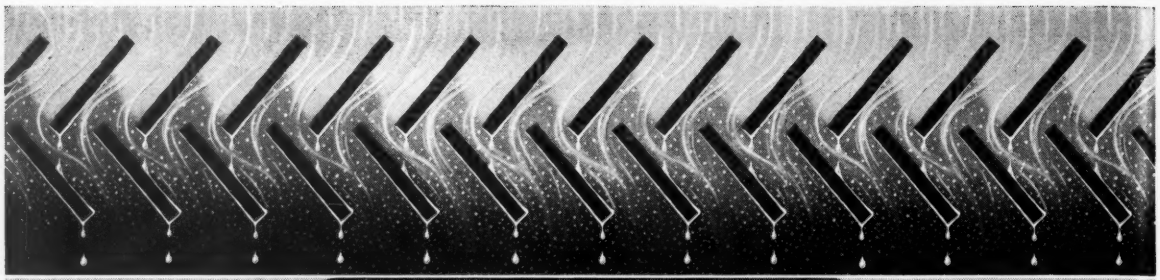

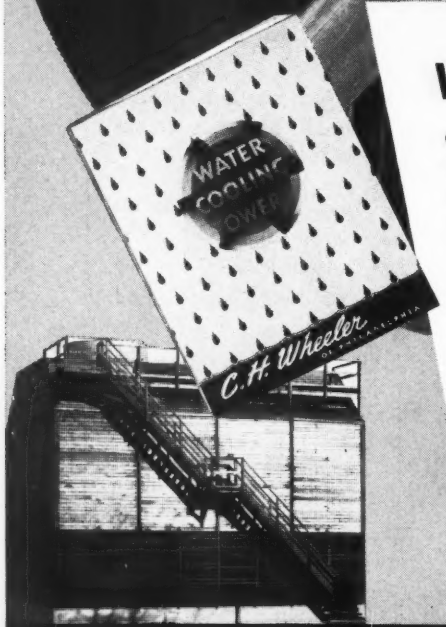

Wind Maker, Not a Rain Machine

Custom design and careful, experienced engineering of C. H. Wheeler Induced Draft Water Cooling Towers assures minimum water loss, this principally by natural evaporation. Offset Herringbone Drift Eliminators catch all but an imperceptible trace of moisture in the air, thus no mist falls on the landscape adjacent to the tower. Drawing above illustrates how they work. Air passing thru layers of blades changes direction and deposits moisture on the underneath side; this builds into drops and falls downward into the towers. . . . Catalog No. 145 gives other reasons why C. H. Wheeler Towers are used all over the United States and in foreign countries. Write for it today.

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